Pakistan Journal of Life and Social Sciences
www.pjlss.edu.pk

RESEARCH ARTICLE

Exploratory Factor Analysis of Digital Culture Leadership within World-Class Standard Schools in Thailand

Phiraya Chompoowong[1*], Prachyanun Nilsook[2] , Pallop Piriyasurawong[3]

[1,2,3] Division of Information and Communication Technology for Education, Faculty of Technical Education, King Mongkut's University of Technology North Bangkok, Bangkok, Thailand

ARTICLE INFO	**ABSTRACT**
	This study presents the findings of a quantitative study designed to identify the critical leadership factors driving effective digital technology adoption within World-Class Standard Schools (W-CSS). This study was proposed to contribute to a fundamental understanding of the role school leadership must play in order to adequately leverage rapidly evolving digital technologies in education. For this purpose a proposed questionnaire was evaluated by a panel of 9 experts from a cross-section of education and technology fields, for approval as a survey trial to establish initial Reliability values. Sample data was collected from 461 staff representing 40 W-CSS qualifying secondary schools within Thailand applying multi-state randomization. Various Leadership Factors were examined with Exploratory Factor Analysis (EFA) as a statistical check using Principal Component Analysis by Varimax. The statistics highlighted five fundamental components with a factor loading value ranging from 0.526 to 0.810, with the variance explained in the data at 58.81%, providing an Eigan value greater than one. The five components comprised some 66 factors related to technology integration and innovation, creating a digital culture in educational institutions, strategic leadership and governance, digital competencies and lifelong learning, and promoting collaboration in work and communication. The study highlighted emphasis of digital technology to drive change in the work culture of all personnel in educational institutions in order to continuously improve education management and quality of education.

INTRODUCTION

In the modern era, Digital technology has played a significant role in transforming. Increasingly in the last decade, technological changes and innovation have compelled educational institutions to adjust their teaching and learning management models to align with the context of a digital world (Karakose & Tülübaş, 2023). According to Ministry of Education, (2023) of Thailand has set policies for "Transforming Education to Fit in the Digital Era" by focusing on the development of digital competencies of teachers and educational personnel. The use of technology and innovation through various online platforms is promoted by the National Education Plan 2017-2036 which aims to develop quality and effective education management systems and processes (Office of the Secretariat of the Education Council, 2017). Leaders are encouraged to provide a vision and strategy to drive digital transformation. Creating a digital 'culture' in educational institutions requires educational leadership with foresight and ability to integrate technology into learning processes and school management. It is recognized that this development of digital skills extends to both teachers and students, promoting a culture of innovation and learning, as well as developing modern infrastructure and information technology systems (Baporikar, 2019; Chompoowong et al., 2022; Farrell et al., 2024). This concept is in line with the goal of the W-CSS Project)Office of the Basic Education Commission, 2010), which aims to continuously develop the quality

of education to be on par with international levels. Accordingly, Adaptation and development of Digital Culture Leadership for executives, teachers and personnel in international standard schools has become a key focus in the development of Thai education (Office of High School Administration, 2022).

The evolution of the Digital world is transforming society rapidly. As a result, education must adapt quickly. Educational institutions are compelled to develop into digital learning organizations (Karakose et al., 2021; Meepung et al., 2022) that can effectively meet the needs of learners in the digital era)Office of the Basic Education Commission, 2022). However, many educational institutions currently still face challenges with lack of readiness to use digital technology effectively. Traditional work culture remains a major obstacle. Most educational personnel lack the understanding and skills to use digital tools creatively)Chompoowong et al., 2023). The leadership of school administrators influences the work behavior of teachers and educational personnel in schools (Choomsri & Chansirisira, 2021). Therefore, in order for all participants to learn and embrace change, leadership play a key role in imparting the knowledge and ability to nurture a new digital culture driving positive educational change.

Therefore, this research aims to study and analyze the exploratory factors of Digital Culture Leadership (DCL) of teachers and all personnel in international standard schools in order to find ways to develop their potential and strengthen digital skills, which will lead to improving the quality of education in line with international standards and can effectively prepare learners to step into a changing world in the future. It is expected that the results of this research will be particularly useful for the development of indicators and guidelines for the development of DCL in Thai educational institutions.

LITERATURE REVIEW

Educators digital leadership role

The role of teachers in technology leadership has come under an increasing spotlight in the digital era. Educators are expected to be champions of learning and as such society expects them to be at the forefront in comprehending and articulating technology change. This includes competencies, knowledge, expertise, ethics and professional standards, as well as vocational preparation for the next generation)Pakorn et al., 2022), which is a combination of educational expertise and the ability to use digital technology effectively. Teachers themselves need to be a force for change in the education system as digital leader, not only responsible for imparting knowledge, but also developing knowledge (Meepung et al., 2022). Teachers also play a role in applying digital innovation to develop the teaching and learning process itself)Farrell et al., 2024), with an important element being the ability to integrate technology into the learning curriculum. Teachers must creatively design learning activities that use digital tools (Hamzah et al., 2021). Encourage learners to develop critical thinking skills. Problem-solving and creativity through digital media, within continuous self-improvement processes)Garzón-Artacho et al., 2021). Teachers must be enthusiastic about learning new technologies and constantly improving their digital skills so that they can effectively guide and support learners in the digital world (Purwanto, 2023; Troy Frensley et al., 2020). Building a professional learning community in the digital world, teachers must be able to connect and exchange learning with colleagues and access expert advice and various knowledge sources through online platforms (Farrell et al., 2024). In addition digital leadership also encompasses the ability to promote ethics and safety in the digital world, teaching learners to keep up with the media, discretionary use of information and awareness of social responsibility. A key challenge for teachers in digital leadership is to balance the use of technology with the development of human skills needed in the 21st century, such as communication, collaboration, and critical thinking skills (United Nations, 2020; World Economic Forum, 2020). Therefore, teachers' digital leadership is no longer just an option. Rather, it is necessary to improve the quality of learning (Choomsri & Chansirisira, 2021) and prepare learners to cope with the ever-evolving digital world.

Schools work culture

School work culture is an important element that frames the quality and effectiveness of an education system, (Shannon Cooray, 2023) explaining that school work culture consists of shared beliefs, values, attitudes, and practices that shape the environment and behavior within the school. Effective leadership is a key factor in setting that direction and shaping a positive code of conduct through a clear vision.

Collaboration should ensure that teachers and staff support each other. A strong corporate culture encourages teachers and staff to work closely together, exchange knowledge and help each other. The focus on the common goal of developing learners (de Jong et al., 2022), is supplemented by continuous professional development in learning and growth of staff)Garzón-Artacho et al., 2021). Teachers should be encouraged with opportunities for training. To collaborate, exchange experiences and apply new in teaching and learning management (Purwanto, 2023). Learner engagement is pivotal to learning (Troy Frensley et al., 2020), facilitated by open and clear communication between all parties in the school, communication systems are developed, and personnel involvement is valued in decision-making and organizational planning (Ebner, 2023). Emphasis is placed on creating values and beliefs that are used as the foundation for joint operations and decision-making (Lanario et al., 2020; Larsen & Hunter, 2014). Having a strong positive culture affects learners' learning performance, including teacher satisfaction and the overall success of the school (Choi & Kang, 2019; Evans, 2024) In these references authors have proposed important strategies for developing a work culture in the school, including: First, It must start by analyzing the current state of corporate culture. Identify strengths and opportunities for development using data from surveys , interviews, and observation of personnel behavior. The second is to set a common vision and values. Create understanding and acceptance from all parties, applied through a process of continuous engagement and communication. Third, focus on leadership development at all levels by encouraging personnel to be think boldly, taking initiative, and being empowered to make decisions. Creating a positive atmosphere focuses on happiness at work and the life quality of employees, and promoting innovation, encouraging learning and developing educational innovation.

Developing a school culture is a process that requires cooperation from all parties. It focuses on creating an environment conducive to learning and professional development. A strong work culture will directly affect the learning performance of students, teacher satisfaction and the overall success of the school.

World-Class Standard School (W-CSS)

The Ministry of Education, through the Office of the Basic Education Commission, has organized the W-CSS Project in Thailand. The Office of Secondary Education Administration was assigned to implement the project starting in 2010 (Office of the Basic Education Commission, 2010) to develop basic education to be of international quality. It is stated that the characteristics of internationality include teaching and learning management (curriculum and teaching) and quality system management. The stated characteristics of W-CSS are: 1) Learners have the potential to become world citizens, 2) Teaching and learning management comparable to international standards and 3) Quality management system is comparable to international standards, including academic quality, teacher quality, and research to continuously improve education management and improve the quality of education. The management with the quality system consists of the quality of school administrators. Management system, basic factors, and co-development network, visionary executives, academic leadership, and exchange of learning in international education management. Use technology for communication and management. The development of the quality of modern teachers is one of the four frameworks for education reform towards international standards)Office of High School Administration, 2022).

The main mission is to develop schools to be of international quality, including curriculum and teaching and learning. Quality system management requires cooperation from management, teachers, educational personnel and related persons. Have the appropriate knowledge, abilities and qualifications to jointly develop education effectively.

Exploratory Factor Analysis (EFA)

EFA is a statistical method important to quantitative research especially in relation to the fields of social sciences and behavioral sciences. This technique allows researchers to find and identify the relationship structure between the observed variables, with the aim of reducing the number of variables to comprise the main elements that are correlated. The main principle of (Sürücü et al., 2024; Watson, 2017) EFA is to group closely related variables together. Variables within the same element are highly correlated, while the variables of different elements have little or no relationship with each other. Each component will represent a latent variable that the researcher is interested in studying (Carrizosa et al.,

2020). EFA is often used as the first step in determining the appropriate number of measurement factors and finding out which observed variable is an indicator of the latent variable (Brown, 2015).

The EFA analysis process as applied in this study consists of 5 key steps)Watson, 2017; Williams et al., 2010).

   1) Evaluating Factorability: The correlation matrix between the variables was examined using the Kaiser-Meyer-Olkin test (KMO) and Bartlett's test of sphericity. Kaiser's (1974) gave the following guidelines for the interpretation of KMO values as follows: .90 to 1.0 (marvelous), .80 to .89)meritorious), .70 to .79 (middling), .60 to .69 (mediocre), .50 to .59 (miserable), and below .50)unacceptable).

2) Factor Extraction: Divide the covariance in each variable from the specific variance and discrepancy using extraction methods such as Principle Component Analysis)PCA), Maximum Likelihood)ML), and Principal Axis Factoring)PAF).

3) Factor Retention: Determine the factors to be retained using criteria such as Kaiser's greater-than-one rule, the Eigen value is greater than one, the scree chart test indicates the point where the Eigen value begins to flatten, the variance extracted considers explainable variance, and parallel analysis comparing Eigen values with random data.

4) Factor Rotation: Rotate the factor to achieve a simpler structure by applying the orthogonal perpendicular rotation method, consisting of varimax, quartimax, and equamax, and the oblique rotation method, consisting of direct oblimin, and promax.

5) Interpreting Factors: Factor loading to understand and decide which items to maintain, including naming factors. By considering the relationship between variables and factors from element weight values, the proportion of variable variance explained by factors from Communalities, and squared loading from a squared element weight value is the process of identifying variables with high weight values in each factor, considering them together with a theoretical conceptual framework and assigning a name that reflects the latent structure.

The use of EFA is important in many areas, especially in the development and validation of measurement instruments in research. Lanario et al., (2020) explains that EFA is a statistical procedure that helps to infer the causal structure behind it, based on the assumption that the relationship between variables is caused by a common cause, which in mathematics is called a factor and in psychology it is called a structure. It also emphasizes that Štiglic et al., (2023) EFA is an important tool for examining the relationships between variables and structuring their relationships.

This study used the five elements of DCL from the preliminary analysis, including strategic leadership, communication and collaboration, digital culture, digital competency and learning, and technology and innovation, to conduct an EFA analysis to study the factors or variables of DCL, reduce data redundancy, and examine the relationship between the variables in each component (Brown, 2015; Carrizosa et al., 2020). The correlation matrix between variables was examined using the KMO and Bartlett's test of sphericity (Kaiser, 1974), Using PCA method extraction of factor, factor retention to determine the appropriate composition using the Kaiser greater-than-one, extracted variance of the percentage values of total variance explained using values of 50% or more)Watson, 2017), factor rotation use varimax method rotation' orthogonal and factor loading checks, in which those variables are classified as representative of five elements, and the number of factors in each element is separated, how many factors are made up of component factors. This provided a definition of the indicators of DCL characteristics for

W-CSS personnel.

METHODOLOGY

This study aims to analyze the EFA of DCL for W-CSS. The researcher studied the factors from the concept of theory and document synthesis research related to digital leadership, digital culture, smart schools, smart school personnel and smart school technology within years 2019-2023, in the

previous study. The data was used to create a questionnaire on DCL, which was used to collect data from a sample and the results were used to analyze the exploratory factors of DCL.

Population and sample

Population: Principal and administrators, Teachers and school personnel in the W-CSS Project in Thailand, the sample group consists of: director deputy director, specialist teachers, and expert teachers of W-CSS affiliated to 4 secondary education regional offices, totaling 40 secondary schools, which had attained the quality accreditation criteria of the Office of the Basic Education Commission Quality Award (OBECQA) using a multi-stage random sampling method with a total sample size of 1,546 people, the appropriate sample size for elemental analysis being more than the required 200)n> 200-400))Newsom, 2023).

Instrument

The tool used for the research is a five-level Likert Rating Scale questionnaire, developed from a study by)Chompoowong et al., 2023) on the digital culture leadership of school personnel according to international standards. The results of the study consist of five elements: strategic leadership, communication and collaboration, digital culture, digital competency and learning, and innovation and technology. In this study, the researcher developed the five elements together with semi-structured interviews with W-CSS administrators to study the data on Digital Culture Leadership Factors (DCLF) and create a digital culture leadership questionnaire and obtain an accuracy assessment content validation by experts in education administration, educational standards, and educational technology by checking the accuracy of 0.91 and experimenting with try-out data from a sample of 30 administrators of W-CSS. And to analyze the reliability of the tools used in the research using statistics Conbach's Alpha has a reliability value of 0.99. Based on the evaluation by experts and the trial of the questionnaire, the researcher updated the digital culture leadership questionnaire divided into five areas with 82 questions, for collecting data with a sample and developing it into an online questionnaire through Google Forms.

Data collection and analysis

Data Collection The researcher used the method of sending electronic mail to send a letter of courtesy to request data responses by answering a questionnaire on DCL within nominated W-CSS in Thailand. The Director Deputy Director, Special Specialist Teacher, and Specialist Teacher were typical respondents. The details of the online questionnaire were provided through scanning the QR code to answer the questions in the online form and received 461 responses. IBM SPSS Statistics 29.0.2.0 provided determination of descriptive statistics, including frequency, percentage, mean, standard deviation, and EFA. In this study, the researcher would like to present the resulting EFA. This is an investigation of DCLF by statistical data testing to reduce data redundancy by reducing the number of variables, and categorizing them into five elements that are meaningfully correlated as factors that can be used as agents to explain the structure of the elements.

RESULT

The Digital Culture Leadership Questionnaire was divided into five areas with 82 items based on the evaluation of validity by experts and the results of the reliability analysis from the data collection trial. Before the use of the final form, data was collection from a sample group of W-CSS personnel to analyze initial results. EFA found that 66 items of DCLF obtained from the survey element analysis met the criteria. Using varimax rotation solution, there are some items where the element weight is less than 0.50 so were eliminated from the final form. The researcher presents the results of the analysis of the following elements of the DCLF.

Assessing the suitability of information

The correlation matrix test between variables is a preliminary check of the suitability of the preliminary data in the analysis of the Kaiser-Meyer-Olkin (KMO) element and the Bartlett's Test of Sphericity values as shown in Table 1.

Table 1 KMO and Bartlett's Test DCL structure

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	Bartlett's Test of Sphericity		
	Approx. Chi-Square	df	Sig.
0.934	23717.729	2145	0.001

From the KMO test to determine its suitability for factor analysis. A KMO value of .934 indicates that the data are suitable for very good elemental analysis (Kaiser, 1974; Watson, 2017) see Bartlett's Test of Sphericity to identify the relationship between two or more variables that provide a statistically significant probability that the matrix is correlated. The Bartlett's Test of Sphericity value was 23717.729 at a significant level of <.001, indicating that the variable was sufficiently correlated to be used for factor analysis.

Extraction of elements

Element extraction by variance determination (Total variance explained). The researchers used it to measure the variables studied to determine the appropriate elements. From the analysis, it was possible to classify the variables in each element with an eigen value greater than one, as shown in Table 2.

Table 2 Total variants explained for DCLF

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	18.576	28.146	28.146	18.576	28.146	28.146	8.720	13.212	13.212
2	8.394	12.718	40.864	8.394	12.718	40.864	8.430	12.772	25.985
3	5.696	8.630	49.494	5.696	8.630	49.494	7.808	11.831	37.816
4	4.263	6.460	55.953	4.263	6.460	55.953	7.113	10.778	48.593
5	1.888	2.860	58.814	1.888	2.860	58.814	6.746	10.221	58.814

From Table 2, the cumulative variance was 58.814 %, with an acceptable value of not less than 50 % (Bartlett, 1954) Analysis of factors and variables in the study was conducted by PCA and varimax rotation to classify the questions or observed variables of the five elements, in order of elements one to five with sums of squared values of 8.720, 8.430, 7.808, 7.113, 6.746, and 38.817, and percent of trace are 13.212, 12.772, 11.831, 10.778, and 10.221

Rotated component matrix of DCLF

Rotated component matrix using the varimax solution method to show the relationship between elements and factors. It was found that the factor loading value changed compared to the factor loading value before rotation. The structure after the DCL analysis test showed that only 66 factors met the conditions, and the factor loading value was more than 0.5 and the communality value as shown in Table 3.

Table 3 List of DCLF from rotated component matrix analysis

Component	Rotation Component Matrix														
1	F58	F59	F60	F61	F62	F63	F66	F65	F54	F69	F67	F73	F72		
	.783	.780	.780	.765	.764	.761	.758	.744	.732	.683	.670	.650	.553		
2	F74	F75	F76	F80	F35	F36	F37	F42	F43	F44	F77	F78	F79		
	.810	.802	.798	.791	.784	.781	.781	.780	.770	.759	.747	.710	.557		
3	F1	F4	F5	F6	F8	F12	F68	F70	F26	F27	F28	F29	F31		
	.774	.769	.765	.758	.757	.748	.742	.736	.734	.729	.717	.578	.576		
4	F45	F46	F47	F48	F49	F50	F52	F53	F54	F55	F56	F57			
	.751	.746	.715	.715	.713	.695	.684	.654	.634	.631	.591	.526			
5	F11	F23	F15	F40	F16	F17	F18	F19	F20	F21	F22	F32	F33	F34	F41
	.713	.705	.698	.675	.673	.667	.659	.654	.654	.642	.641	.640	.625	.608	.605

From Table 3, the results of the element extraction by the PCA method with the varimax rotation method (Rotated Component Matrix analysis) have the correlation coefficient between the variable and the element that has been rotated. It was found that the elements of DCL are rearranged according to the weight of the elements after the rotation and then sorted the descending variables of each factor. As a result of rotating component analysis, the variables that are related to a particular element become clearer. The elements were extracted into five components with 66 variables that are related to each element, which according to the results of the previous study, namely strategic leadership, communication and collaboration, digital culture, digital competency and learning, and innovation and technology. Subsequently, the results of this study have been reviewed by the researcher to revise the name of the component and present the results of the rotation of component analysis and the communality value as follows:

Component 1 consists of 13 variables in the order of F59, F58, F60, F61, F62, F63, F66, F65, F54, F69, F67, F73, and F72 with a factor loading value of 0.783 - 0.553, the communality value of 0.717 - 0.457, explaining the variance of 13.212 %. The first component may be named the Integration of technology and innovation.

Component 2 consists of 13 variables: F74, F75, F76, F80, F35, F36, F37, F42, F43, F44, F77, F78, and F79, with a factor loading value of 0.810 - 0.557, the communality value of 0.709 - 0.382, explaining the variance of 12.772 %. The second component may be named the Cultivation of digital culture.

Component 3 consists of 13 variables: F1, F4, F5, F6, F8, F12, F68, F70, F26, F27, F28, F29, and F31, with a factor loading value of 0.774 - 0.576, the communality value of 0.661 - 0.396, explaining the variance of 11.831%. The third component may be named Strategic leadership and governance.

Component 4 consists of 12 variables: F45, F46, F47, F48, F49, F50, F52, F53, F54, F55, F56, and F57, with a factor loading value of 0.751 - 0.526 and a communality value of 0.732 - 0.494, explaining the variance of 10.778 %. The fourth component may be named Digital competency building and lifelong learning.

Component 5 consists of 15 variables: F11, F23, F15, F40, F16, F17, F18, F19, F20, F21, F22, F32, F33, F34, and F41, with a factor loading value of 0.713 - 0.605, communality value of 0.535 - 0.374, explaining the variance of 10.221%. The fifth component may be named Effective communication and collaboration.

DISCUSSION

Thailand has a defined framework for education reform to international standards, and has organized the W-CSS Project to develop schools at the basic education level. Each school is encouraged to focus on the use of information and communication technology (ICT) in curriculum and teaching, and quality management)Office of High School Administration, 2022). by developing the school's core personnel regarding the preparation of strategic plans, teaching and learning management comparable to international standards, both in terms of academics, professional teacher development, and research. Academic leadership, basic factors. Effective management system and joint development network)Office of High School Administration, 2018). Currently, there is a large variety of digital technologies available to education. The work style of all personnel in educational institutions must embrace these technologies to increase efficiency. The researcher conducted this study with the aim of analyzing the factors of DCL that can be used as a guide or tool to develop the personnel of W-CSS in Thailand to have characteristics that are suitable for the approach of education reform to international standards in the digital era. Using EFA statistical analysis, the analysis of factors identified suitable elements in the study eliminating redundant items (Sürücü et al., 2024). Explanation of the relationship between all the variables and isolate the appropriate factors)Brown, 2015; Finch, 2020). Therefore, the EFA analysis using varimax rotation with a list of 82 items, and eliminating 16 items with a lower weight value than the specified value for the factor loading,)Hair et al., 2019; Watson, 2017), a remaining 66 items explains variability in the data, so were retained as the required number of components in the actual research instrument, and then look at the Bartlett's test results for sphericality. Using the analysis of the right factor, (Kaiser, 1974) the approach to determining the KMO value greater than 0.90 to 1.0 is considered marvelous (Watson, 2017), while the cumulative variance of the formation of the EFA is 58.81%. From the extraction of all variance explanations using a value of 50% or more)Bartlett, 1954; Watson, 2017), based on the determination that the factor loading value must be greater than 0.5, five components can be extracted, a total of 66 key variables resulted as follows:

1) Technology and Innovation involves the integration of innovation and technology in the field of education and its application, comprising 13 variables: Organizing work data and creating high-quality media, Use information technology for cost-effective and effective communication, Able to identify, survey, and select the correct use of technological tools and equipment, Ability to integrate appropriate technology for teaching effectively, Be capable to ask questions and see opportunities for innovation, Can design prototypes and present innovations in teaching and learning, Provide an online teaching and learning model using a computer or teaching assistant, Creatively collaboratively creating an environment for innovation, Create new learning experiences with technology, Ability to integrate information technology into teaching and learning, produce technology materials that learners can choose to study according to their aptitudes, and integrate technology appropriately to learners' differences. In line with the Basic Education Development Plan (2023-2027))Office of the Basic Education Commission, 2022) to integrate the use of resources of educational institutions affiliated to the Office of the Basic Education Commission by using space as a base to achieve maximum efficiency, be able to manage learning with quality by using technology to support and be an innovator, and in line with the study by Hafiza Hamzah et al., (2021) the integration of digital technology in teaching, assessing learners based on the digital learning environment. And the study of Karakose et al., (2021) the use of digital technology, digital transformation support, supporting

digital learning culture and digital leadership skills, and the study of Choomsri & Chansirisira, (2021) and Farrell et al., (2024) the study found that supporting the effective integration of technology media to promote the use of technology tools in work and using digital platforms to create innovations provides good learning experience for learners.

2) Digital Culture involves creating a digital culture in the work of education, consisting of 13 variables, including: Critical thinking skills, Seeing the benefits of integrating digital tools in work, Cybersecurity Management, Skills to use technology in an empathetic manner and build good relationships with others (Digital Empathy), Follow the evolution of up-to-date digital thinking, Ability to manage data and digital footprint, Focus on digital literacy, Adaptive thinking to digital transformation, Able to adapt to the phenomenon of digital technology, Stay up to date with new technological changes, Understand and recognise the importance of technology, Accept the use of technology, and have a thorough and unlimited data connection between internal and external departments)Office of High School Administration, 2018) in accordance with the safe, appropriate, and ethical use of online data. Social awareness must be clear about how to use technology, with whom, when, and in line with the study of Choi & Kang, (2019 and Evans, (2024) about the strategy to create a development-oriented work culture It requires understanding and cooperation from all parties to create an environment that promotes learning. The development and professionalism of teachers and educational personnel is in line with the study of Karakose et al., (2021) administrators to support digital transformation. Create a digital learning culture in schools.

3) Strategic Leadership is related to strategic leadership and good governance, consisting of 13 variables: Understanding and realizing the status and technological potential of the organization; Putting vision and strategy into practice, Disseminate and collaborate digitally in educational institutions, Professional development strategy in technological capabilities, Digital tools are used in academic planning, Understand and comply with the digital policies and regulations of educational institutions, Information system and digital platform to help develop and improve the work management process, Information technology activities are integrated into the curriculum, Technology readiness and emphasis on the use of digital in the context of education, How to using digital data for operation, Jointly creating a culture that drives the organization with digital data, Practice the correct and appropriate use and analysis of digital data, This is in line with)Chomsri et al., 2020) stated that strategic management is an important part of education in the digital era, in line with the development of the quality of modern teachers in accordance with the framework of the educational reform guidelines to international standards)Office of High School Administration, 2018), and in line with the study Ebner, (2023) of the emphasis on the participation of personnel in decision-making and organizational planning, and visionary leadership. Building values and beliefs as a guide in operations and joint decision-making, determining the direction of the school as a whole and shaping a positive code of conduct (Lanario et al., 2020; Larsen & Hunter, 2014; Shannon Cooray, 2023).

4) Digital Competency and learning involves building digital competencies and supporting lifelong learning in digital technology. It consists of 12 variables including: Knowledge of information and technology, Knowledge of digital media and digital content creation, Knowledge of intellectual property in digital technology, having operational skills in digital technology, Think critically about digital technology, Have an understanding of digital culture and digital society, Have basic digital skills, Have the ability to use advanced technology related to the profession, Have an emotional development in dealing with digital problems, Access to continuous digital learning, Practice and receive training to increase digital potential, self-development, and be empowered, and Supporting continuous digital professional development. In line with the study of Purwanto, (2023) stating that the purpose of professional development is to create a skill set and knowledge base to be mastered. Create learning opportunities to create new skills that can be used in work and professional development. Developing personnel to have basic skills in technology. The use of the Internet network and ICT equipment to assist school administrators. Teachers and educational personnel to be competent in technology and encourage continuous professional self-development, and promote learning and innovation. In the study of Evans, (2024) and Garzón-Artacho et al., (2021).

5) Collaboration and Communication involves effective communication and collaboration in education. It consists of 13 variables including: The routine use of technology for communication, search, creation and storage of documents, Sharing digital information both internally and externally, Digital teamwork between personnel in educational institutions, Perform to the best of ability to achieve goals responsibly, Co-create an online professional learning network, Technology tools are used for digital collaboration, Awareness of cyber security in digital networks, Have digital communication skills with clear messages and be a good role model, Positive attitude towards oneself and others in digital communication, Realize the benefits of digital communication, Problem-solving skills enhanced by the use of digital information, Knowledge and ability to solve problems using digital technology, brainstorm ideas to solve digital problems, and Be ready to improve and correct work diligently. In line with the study of Choi & Kang, (2019) and Evans, (2024) ability to think critically and evaluate digital data How to collaborate, so that teachers and staff support each other, as well as clear directives from management, and create an atmosphere conducive to happy work. The use of ICT to communicate and collaborate with others effectively and appropriately is now necessary for communication and collaboration with others)Baporikar, 2019; Wongkitrungrueang, 2018).

CONCLUSION AND FUTURE WORK

This study aims to analyze DCLF that will lead to the development of tools to measure or validate the characteristics of DCL of personnel in the context of W-CSS in Thailand. From the results of this research, some DCLF have been developed and a valid DCL approach can be applied, which has been statistically tested by EFA analysis. This research results in digital culture leadership factors that will lead to the creation of indicators for the development of digital culture leadership evaluation of international standard school personnel. The five established components including: Cultivating digital culture, strategic leadership, digital competency building and lifelong learning, and effective communication and collaboration consist of all 66 factors. This can assist Teachers and all personnel in educational institutions to develop the educational context in the country to be on par with the international level in line with global digital transformation.

Future research studies will use the results of these 66 DCLF to provide further confirmatory factor analysis to verify the consistency of empirical data and develop digital culture leadership indicators of school personnel. This will result in a clear and credible set of indicators and help build an in-depth understanding of the key elements of DCL. It can be applied in personnel evaluation or policy development that promotes digital culture in educational institutions.

ACKNOWLEDGMENT

Declaration of Conflicting Interests

The authors confirm that there are no known conflicts of interest associated with this publication and have received no significant financial support for this work that could have influenced its outcome.

REFERENCES

Baporikar, N. (2019). Educational Leadership for Quality Teacher Education in Digital Era. In Handbook of Research on Educational Planning and Policy Analysis (pp. 241–255). Port Harcourt: Pearl Publishers. https://www.researchgate.net/publication/334430026

Bartlett, M. S. (1954). A Note on the Multiplying Factors for Various X 2 Aproximations. Journal of the Royal Statistical Society, 16(2), 296–298. https://doi.org/10.1111/j.2517-6161.1954.tb00174.x

Brown, T. A. (2015). Confirmatory factor analysis for applied research, 2nd ed. The Guilford Press. https://psycnet.apa.org/record/2015-10560-000

Carrizosa, E., Guerrero, V., Romero Morales, D., & Satorra, A. (2020). Enhancing Interpretability in Factor Analysis by Means of Mathematical Optimization. Multivariate Behavioral Research, 55(5), 748–762. https://doi.org/10.1080/00273171.2019.1677208

Choi, J., & Kang, W. (2019). Sustainability of cooperative professional development: Focused on teachers' efficacy. Sustainability (Switzerland), 11(3). https://doi.org/10.3390/su11030585

Chompoowong, P., Karapakdee, J., Srisawat, S., Issaro, S., & Khampuong, P. (2022). Digital culture leadership in elementary education. International Journal of Educational Communications and Technology(IJECT), 2(2), 24–32.

Chompoowong, P., Nilsook, P., & Piriyasurawong, P. (2023). Digital Culture Leadership for Smart Schools. 2023 Research, Invention, and Innovation Congress: Innovative Electricals and Electronics (RI2C), 66–71. https://doi.org/10.1109/RI2C60382.2023.10355939

Chomsri, A., Sarnswang, S., & Buasuwan, P. (2020). Innovative Leadership of School Administrators Affecting the Effectiveness of World Class Standard Schools in the Digital Era under the Secondary Educational Service Area Office 1 [Kasetsart University]. http://edad.edu.ku.ac.th/Thesis%20IS%2026/37%20%20Anuchit%20Chomsri.pdf

Choomsri, C., & Chansirisira, P. (2021). The Confirmatory Factor Analysis Model Of Being The Smart School In The Digital Age Under The Office Of The Basic Education Commission (Vol. 25). http://annalsofrscb.ro

de Jong, L., Meirink, J., & Admiraal, W. (2022). School-based collaboration as a learning context for teachers: A systematic review. International Journal of Educational Research, 112. https://doi.org/10.1016/j.ijer.2022.101927

Ebner, A. (2023). Clarity of Communication for Facilitating Change. In Journal of Online Learning Research (Vol. 9, Issue 2).

Evans, L. (2024). Reconceptualizing effective professional development for teachers: shifting from causal chains and generativity to complexity and employee-centrism. International Journal of Leadership in Education, 1–23. https://doi.org/10.1080/13603124.2024.2430019

Farrell, R., Rice, M., & Qualter, D. (2024). Navigating the Digital Transformation of Education: Insights from Collaborative Learning in an Erasmus+ Project. Education Sciences, 14(9). https://doi.org/10.3390/educsci14091023

Finch, H. W. (2020). Exploratory Factor Analysis. SAGE Publications, Inc. https://doi.org/10.4135/9781544339900

Garzón-Artacho, E., Sola-Martínez, T., Romero-Rodríguez, J. M., & Gómez-García, G. (2021). Teachers' perceptions of digital competence at the lifelong learning stage. Heliyon, 7(7). https://doi.org/10.1016/j.heliyon.2021.e07513

Hafiza Hamzah, N., Khalid, M., & Wahab, J. A. (2021). The effects of principals' digital leadership on teachers' digital teaching during the covid-19 pandemic in Malaysia. Journal of Education and E-Learning Research, 8(2), 216–221. https://doi.org/10.20448/journal.509.2021.82.216.221

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2019). Multivariate Data Analysis (8th ed.). Annabel Ainscow. www.cengage.com/highered

Hamzah, N. H., Khalid, M., & Wahab, J. A. (2021). The effects of principals' digital leadership on teachers' digital teaching during the covid-19 pandemic in Malaysia. Journal of Education and E-Learning Research, 8(2), 216–221. https://doi.org/10.20448/journal.509.2021.82.216.221

Kaiser, H. F. (1974). An index of factorial simplicity. Psychometrika, 39(1), 31–36. https://doi.org/10.1007/BF02291575/METRICS

Karakose, T., Polat, H., & Papadakis, S. (2021). Examining teachers' perspectives on school principals' digital leadership roles and technology capabilities during the covid-19 pandemic. Sustainability (Switzerland), 13(23). https://doi.org/10.3390/su132313448

Karakose, T., & Tülübaş, T. (2023). Digital Leadership and Sustainable School Improvement—A Conceptual Analysis and Implications for Future Research. Educational Process: International Journal, 12(1), 7–18. https://doi.org/10.22521/EDUPIJ.2023.121.1

Chompoowong et al.   *Exploratory Factor Analysis of Digital Culture Leadership*

Lanario, J. W., Hyland, M. E., Menzies-Gow, A., Mansur, A. H., Dodd, J. W., Fowler, S. J., Jones, R. C., & Masoli, M. (2020). Validation of subscales of the Severe Asthma Questionnaire (SAQ) using exploratory factor analysis (EFA). Health and Quality of Life Outcomes, 18(1). https://doi.org/10.1186/s12955-020-01593-9

Larsen, D. E., & Hunter, J. E. (2014). Separating Wheat from Chaff: How Secondary School Principals' Core Values and Beliefs Influence Decision-Making Related to Mandates. NCPEA International Journal of Educational Leadership Preparation, 9(2).

Meepung, T., Nilsook, P., & Wannapiroon, P. (2022). Higher Education Management to Digital Entrepreneurial University. Journal of Theoretical and Applied Information Technology, 100(10), 3212–3220. https://www.jatit.org/volumes/Vol100No10/5Vol100No10.pdf

Ministry of Education. (2023, January 4). Policy and focus of the Ministry of Education Fiscal year 2024. https://moe360.blog/2023/01/04/policy-and-focus-moe-fiscal-year-2024/

Newsom, J. T. (2023). Summary of Minimum Sample Size Recommendations. Structural Equation Modeling. https://web.pdx.edu/~newsomj/semclass/ho_sample%20size.pdf

Office of High School Administration. (2018). Towards World-Class Standard Education (M. of E. Office of The Basic Education Commission, Ed.). Agricultural Cooperative Community Printing House of Thailand.

Office of High School Administration. (2022). Office of the Basic Education Commission Quality Award Criteria of the Office of the Basic Education OBECQA 2022 - 2025.

Office of the Basic Education Commission. (2010). Quality system management manual.

Office of the Basic Education Commission. (2022). Basic Education Development Plan (2023 - 2027).

Office of the Secretariat of the Education Council. (2017). National Education Plan B.E. 2017 - 2036.

Pakorn, J., Koolnaphadol, T., & Burasirirak, S. (2022). Model of digital leadership for administrators under the authority of the office of the basic education commission. Rachapark Journal, 16(48), 390–410.

Purwanto, M. B. (2023). Professional Growth And Staff Development (How To Encourage Employees To Pursue Professional Development). International Journal of Technology and Education Research, 1(1). https://e-journal.citakonsultindo.or.id/index.php/IJETER

Shannon Cooray, P. (2023). SCHOOL CULTURE AND LEADERSHIP SCHOOL CULTURE AND LEADERSHIP. https://www.researchgate.net/publication/371639809

Štiglic, G., Cilar Budler, L., & Watson, R. (2023). 15 Running a confirmatory factor analysis in R: a step-by-step tutorial. In Innovative Nursing Care (pp. 207–222). De Gruyter. https://doi.org/10.1515/9783110786088-015

Sürücü, L., YIKILMAZ, İ., & Yikilmaz, İ. (2024). Exploratory Factor Analysis (EFA) in Quantitative Researches and Practical Considerations. Gümüşhane Üniversitesi Sağlık Bilimleri Dergisi Derleme Makalesi GUJHS, 13(2), 947–965. https://doi.org/10.31219/osf.io/fgd4e

Troy Frensley, B., Stern, M. J., & Powell, R. B. (2020). Does student enthusiasm equal learning? The mismatch between observed and self-reported student engagement and environmental literacy outcomes in a residential setting. Journal of Environmental Education, 51(6), 449–461. https://doi.org/10.1080/00958964.2020.1727404

United Nations. (2020). A DIGITAL FUTURE FOR ALL? THE IMPACT OF DIGITAL TECHNOLOGIES. https://www.un.org/en/un75/impact-digital-technologies

Watson, J. C. (2017). Establishing evidence for internal structure using exploratory factor analysis. Measurement and Evaluation in Counseling and Development, 50(4), 232–238. https://doi.org/10.1080/07481756.2017.1336931

Williams, B., Onsman, A., Brown, T., Andrys Onsman, P., & Ted Brown, P. (2010). Exploratory factor analysis: A five-step guide for novices. Journal of Emergency Primary Health Care (JEPHC), 8, 2010–990399.

Wongkitrungrueang, W. (2018). Digital Citizen Handbook. Ministry of Digital Economy and Society.

World Economic Forum. (2020, November 18). How has technology changed the world since 2000 | World Economic Forum. Web Page. https://www.weforum.org/stories/2020/11/heres-how-technology-has-changed-and-changed-us-over-the-past-20-years/