

# A New Digital Competence Framework for Primary School Design and Technology Teachers

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## Abstract

The digital competence framework for DT teachers in primary schools was validated using Principal Component Analysis (PCA). With this framework, relevant parties identify the training needs of existing DT teachers or trainee teachers who take the DT subject for continuous self-reflection and improvement. This study was conducted to examine the reliability of the DIGIGLO Digital Competency Assessment instrument using Rasch Model as a measurement of its reliability. Testing and validation were conducted to ensure that the elements of the digital teacher competency framework meet the Principal Component Analysis (PCA) criteria. The purpose was to ensure and confirm that the measured research elements are independent. The study involved 283 primary school Design and Technology teachers in the state of Johor. Respondents answered the online questionnaire using Google Forms to obtain the necessary data for this study. For verifying the digital competency framework, the researcher used the Rasch measurement model approach by conducting Principal Component Analysis (PCA) using Winsteps software. The findings indicate that the validated framework can effectively identify areas for teacher development. Recommendations for policy and practice include targeted training programs and continuous professional development. The results indicate that the framework is reliable and effective for assessing digital competencies, and its implementation can significantly enhance the quality of DT education in primary schools in Johor. Findings of this study provides a model for precise skill assessment and tailored professional development that can be applied across various educational settings to improve vocational training. This approach ensures that TVET educators are equipped with the necessary digital skills to meet the evolving demands of the educational and labor markets, fostering a more digitally adept and competitive workforce.

## 1. Introduction

Digital competence encompasses the knowledge, abilities, and mindsets essential for utilizing Information and Communication Technology (ICT) and digital media to execute tasks and acquire knowledge, as stated by Al Khateeb (2017). The author further elaborates on this notion as the adept, evaluative, and imaginative use of ICT

to attain professional objectives. Teachers assume a pivotal role as role models for the younger generation, underscoring the importance of equipping them with the digital proficiencies that all individuals need to actively participate in the digital era. Krumsvik et al. (2016) documented that educators require three categories of digital competencies: general digital competencies concerning the mastery of fundamental skills and knowledge related to educational technology and digital environments, subject-specific pedagogical digital competencies tied to the application of digital skills in specific academic subjects, and professional digital competencies that pertain to digital proficiencies relevant to the teaching profession but extending beyond instructional activities.

Being dedicated professionals in the realm of education, teachers should possess not only general digital proficiencies for personal and professional use but also specific digital competencies to effectively integrate technology into their teaching methodologies (Louise Starkey, 2020). Numerous educators, including those instructing Design and Technology (DT) subjects, may not have received adequate training in the realm of online teaching and facilitation. They grapple with challenges that encompass deficiencies in digital competences required for conducting online teaching and facilitation, alongside limitations in technical resources like laptops, internet connectivity, and microphones essential for teaching purposes (Al Khateeb, 2017).

According to Cabero (2020), mastering digital competence is one of the most important skills that citizens in general and teachers in particular need to have in the society of the future. One of the primary strategic pillars of Spain's National Digital Competence Plan (MINECO, 2021), which aims to promote sustainable and inclusive economic growth, is the acquisition of Digital Competence by Teachers at All Levels of Education, Including Universities. Since the transformation and improvement of education depends, among other things, on educational action, which presupposes that teachers should have effective digital competencies that would enable them to integrate and implement ICT in the classroom, teachers are essential in the process of integrating such technology pedagogically.

The term "teacher digital competence" refers to the knowledge, skills, and competencies that educators should acquire to perform their educational duties and is derived from the term "digital competence" (Basantes-Andrade et al., 2022). The European Commission's framework served as the foundation for its development in several nations, however different models of development and assessment are used in its implementation. This idea of digital competence acknowledges how closely tied to technology modern education is, and that for instructors to effectively interact with pupils in a technologically advanced society, they must not only be subject matter experts but also be digitally literate. According to Durán (2019), teacher digital competence is a set of knowledge, abilities, and behaviors needed for teachers to utilize ICT effectively from a variety of viewpoints, including technological, informational, multimedia, communicative, collaborative, and ethical. To put it another way, teachers who want to effectively integrate ICT into their teaching methods should have the skills, knowledge, and mindset to do so. To incorporate this technology into learning, they should also consider pedagogical-didactic standards to improve learning outcomes and create a more engaging learning environment. Digital competence is increasingly recognized as a crucial skill for educators in the 21st century, enabling them to effectively integrate technology into their teaching practices (Gisbert Cervera & Caena, 2022). However, recent studies indicate that many primary school teachers, particularly those teaching Design and Technology (DT), lack adequate digital competencies. This gap hinders their ability to deliver high-quality, technology-enhanced education (Alarcón et al., 2020). Therefore, this study aims to validate a digital competence framework tailored for primary school DT teachers, addressing this critical need and supporting continuous professional development.

## 2. Methodology

The study conducted is a survey that utilizes a quantitative approach, and the research instrument used was an online questionnaire, adapted from the DIGIGLO instrument, using Google Forms. The population for this study consists 283 of primary school Design and Technology (DT) teachers in the state of Johor who have been teaching the DT subject for five years or more. A set of online questionnaires, using Google Forms, consists of two sections that identified the elements of teachers' digital competence. In the presented Table 1, two primary sections were delineated, focusing on distinct aspects of the study. Section A concerned with Demography, assessed through a Multiple Option method, comprising four items. Section B, significantly more extensive, delves into the intricacies of Teacher's Digital Competency, employing the Likert Scale as its evaluation method. This section is further segmented into eight subcategories: Professional Engagement, Digital Resources, Digital Pedagogy, Assessment, Empowering Learners, Facilitating Learners' Digital Competence, Digital Environment, and Extrinsic Digital Commitment. Each of these categories encompasses a specific number of items, with Professional Engagement, Digital Resources, Digital Pedagogy, Assessment, and Empowering Learners each containing six items. Facilitating Learners' Digital Competence comprises four items, Digital Environment includes five, and Extrinsic Digital Commitment also consists of four items. Altogether, Section B accounts for a total of 43 items that offered a comprehensive evaluation of the various facets of Teacher's Digital Competency. This detailed and segmented approach enables a nuanced understanding of the digital competencies that are critical in modern educational settings.

**Table 1** Questionnaire items

Section	Aspect	Method	No. of Items
A	Demography	Multiple Option	4
B	<b>Teacher's Digital Competency</b>	Likert Scale	
	Professional Engagement		6
	Digital Resources		6
	Digital Pedagogy		6
	Assessment		6
	Empowering Learners		6
	Facilitating Learners' Digital Competence		4
	Digital Environment		5
	Extrinsic Digital Commitment		4
		Total	47

Principal Component Analysis (PCA) was used to determine the key components of the digital competence framework for primary school teachers. Principal Component Analysis (PCA) is a linear transformation that converts data into a new coordinate system, such that the new variables, the principal components, are linear functions of the original variables, uncorrelated, and account for the largest variance (Jolliffe & Cadima, 2016). This means that the first coordinate captures the most variance in the data, the second coordinate captures the second-largest variance, and so on. PCA is a multivariate analysis that transforms the original correlated variables into new variables (Linacre & J.M., 2010). The purpose of conducting this Principal Component Analysis in this study is to ensure and confirm that the measured constructs or elements are independent. This means that each construct or element of a teacher's digital competence should not be unidimensional, with no other factors affecting it. To verify the digital competency framework, the researcher used the Rasch model approach by conducting Principal Component Analysis (PCA) using Winsteps software.

### 3. Results

In this study, the researcher undertook a rigorous process of testing and verification to ascertain that the components of the teacher's digital competence framework conformed to the stringent criteria set forth by Principal Component Analysis (PCA). The primary objective of this analytical approach was to validate the independence of the elements within the research scope. This necessitates that each element under investigation to be unidimensional, ensuring that its properties are not subject to external influences or factors. A critical step in this validation process involved the scrutiny of items based on their PTMEA CORR values. The focus was directed exclusively towards items demonstrating positive PTMEA CORR values, as these were deemed to be not only congruent but also uniquely representative of the teacher's digital competency framework. This methodological rigor highlights the commitment to ensuring the validity and specificity of the research elements within the domain of digital competence in education.

The analysis of the Point-Measure Correlation (PTMEA CORR) values across various elements of a teacher's digital competence framework yields significant insights into the alignment of individual items with the overarching constructs they were intended to measure. These findings are integral to validating the efficacy of the framework in capturing the nuances of digital competence among educators. Within the domain of Professional Engagement (E1), items Q6 through Q10 demonstrate robust correlations, with PTMEA CORR values ranging from 0.76 to 0.87. These figures suggested a substantial alignment with the construct. However, item Q11 exhibits a notably lower correlation of 0.62, which may prompt further scrutiny into its relevance or formulation. The Digital Resources component (E2) presents a remarkable consistency, with all items from Q12 to Q17 displaying high correlations (0.81 to 0.86). This uniformity indicates a strong representation of the Digital Resources dimension within the framework. In assessing Digital Pedagogy (E3), the PTMEA CORR values span from 0.80 to 0.89 for items Q18 to Q23, indicating an excellent congruence with the digital pedagogy construct and affirming their validity as measures of this domain.

The Assessment element (E4) is similarly characterized by high correlations, particularly notable in items Q26 to Q28, with values reaching up to 0.90. This suggests these items are particularly precise indicators of assessment-related digital competencies. The Empowering Learners category (E5) shows a progressive correlation from 0.81 to 0.88 for items Q30 to Q34, reinforcing the relevance and appropriateness of these items in measuring the empowerment aspect of digital competence. For the element Facilitating Learners' Digital Competence (E6), items Q35 to Q38 stand out with exceptionally high correlations, especially Q36 and Q37, both at 0.91, signifying their strong association with facilitating learners' digital competence. The Digital Environment (E7) maintains a robust correlation for most items, except for Q42, which at 0.71 indicating a divergence from the expected construct alignment and could benefit from a re-evaluation. Lastly, Extrinsic Digital Commitment (E8)

showcases consistent correlations for items Q45 to Q48 (0.82 to 0.85), indicating these items aptly represent the extrinsic motivation factors in digital engagement.

**Table 2** *PTMEA CORR value revised analysis based on item polarity*

Element	Item	PTMEA CORR
E1: Professional Engagement	E1 Q5	0.83
	E1 Q6	0.87
	E1 Q7	0.76
	E1 Q8	0.78
	E1 Q9	0.8
	E1	0.62
	Q10	
	E2	0.86
	Q11	
	E2	0.85
E2: Digital Resources	Q12	
	E2	0.84
	Q13	
	E2	0.81
	Q14	
	E2	0.84
	Q15	
	E2	0.86
	Q16	
	E3	0.8
E3: Digital Pedagogy	Q17	
	E3	0.89
	Q18	
	E3	0.89
	Q19	
	E3	0.89
	Q20	
	E3	0.89
	Q21	
	E3	0.89
E4: Assessment	Q22	
	E4	0.81
	Q23	
	E4	0.83
	Q24	
	E4	0.9
	Q25	
	E4	0.89
	Q26	
	E4	0.89
E5: Empowering Learners	Q27	
	E4	0.82
	Q28	
	E5	0.81
	Q29	
	E5	0.83
	Q30	
	E5	0.85
	Q31	
	E5	0.87
Q32		
E5	0.88	
Q33		

Element	Item	PTMEA CORR
E6: Facilitating Learners' Digital Competence	E6	0.84
	Q34	
	E6	0.91
	Q35	
	E6	0.91
E7: Digital Environment	Q36	
	E6	0.89
	Q37	
	E7	0.86
	Q38	
	E7	0.84
	Q39	
	E7	0.85
	Q40	
	E7	0.71
E8: Extrinsic Digital Commitment	Q41	
	E7	0.83
	Q42	
	E7	0.81
	Q43	
	E8	0.82
	Q44	
	E8	0.82
	Q45	
	E8	0.85
	Q46	
	E8	0.83
	Q47	

Referring to Table 2 PTMEA CORR Value Revised Analysis Based on Item Polarity, the researcher found that all items for the study element have a positive PTMEA CORR value. Based on this analysis, all the items were accepted because they can measure the elements of the study and they are unidimensional. According to Linacre & J.M. (2010), to meet the criteria of PCA analysis, the elements of the study should be unidimensional when:

- i. The percentage of raw variance (raw variance explained by measure) in the measurement of the Rasch model is over 40%.
- ii. The percentage of unexplained variance in the first contrast (first contrast unexplained variance) is less than 10 % and.
- iii. The first contrast eigenvalue is less than 3.0.

### 3.1 Professional Engagement

**Table 3** Principal component analysis of element 1 of professional engagement

Analysis Variants	Eigen Value	Empirical (%)	Modelled (%)
Raw variance explained by measurements	10.3	67.2	67
Raw variance explained by respondents	8.3	54.6	54.4
Raw variance explained by items	1.9	12.6	12.6
The amount of raw variance is not explained	5	32.8	33
Variance is not explained in the first contrast	2.3	14.8	45.2

- Raw variance explained by measurements: The largest proportion of variance, 67.2% empirically and 67.0% as modeled, is accounted for by the measurements. An eigenvalue of 10.3 indicates a strong factor or principal component that the measurements are capturing. This suggests that the measurement tool used in the study is effectively capturing a significant portion of the variance in the data, indicating a high level of reliability

- Raw variance explained by respondents: The second-largest source of variance is attributed to the respondents themselves, both empirically and in the modeled data, at slightly over half (54.6% and 54.4%, respectively). An eigenvalue of 8.3 shows that individual differences among respondents contribute substantially to the variance, suggesting that respondent characteristics significantly affect the outcomes.
- Raw variance explained by items: A smaller portion of variance is explained by the items, at 12.6% for both empirical and modeled values, with an eigenvalue of 1.9. This indicates that the individual items of the questionnaire or measurement instrument contribute to some extent to the overall variance but are not as influential as the measurements or respondents.
- The amount of raw variance is not explained: There is a notable amount of variance, 32.8% empirically and 33.0% as modeled, that is not accounted for by the study. With an eigenvalue of 5.0, this suggests that there are other factors not captured by the study that are influencing the results.

Variance is not explained in the first contrast: Interestingly, there is a discrepancy between the empirical (14.8%) and modeled (45.2%) data concerning the variance not explained in the first contrast, indicated by an eigenvalue of 2.3. This disparity suggests that the model may not be fully capturing the complexity of the data or that there may be additional latent variables or constructs that are not accounted for in the first principal component or factor.

### 3.2 Digital Resources

Table 4 presents the outcomes of the principal component analysis pertaining to the second element, Digital Resources. The empirical measurements elucidate 68.0% of the raw variance, while the modeled data accounts for 67.4%. The eigenvalue associated with the first contrast is reported at 2.0, accompanying a 9.2% fraction of variance that remains unexplained within this initial contrast. These results suggest that the Digital Resources element exhibits unidimensionality, indicating that it is likely to be influenced by a single underlying construct.

**Table 4** *Digital resources*

<b>Analysis Variants</b>	<b>Eigen Value</b>	<b>Empirical (%)</b>	<b>Modeled (%)</b>
Raw variance explained by measurements	14.9	68	67.4
Raw variance explained by respondents	13.4	61.1	60.6
Raw variance explained by items	1.5	6.9	6.8
The amount of raw variance is not explained	7	32	32.6
Variance is not explained in the first contrast	2	9.2	28.8

### 3.3 Digital Pedagogy

The principal component analysis delineated in the Table 5 indicates a substantial proportion of the variance is accounted for by the measurements, with an eigenvalue of 18.4 and empirical and modeled percentages closely aligned at 75.4% and 75.1%, respectively. Such a high level of variance explained suggests a strong unidimensional structure, where a single latent factor likely underpins the measurements. The variance accounted for by respondents also supports this unidimensionality, with an eigenvalue of 14.8 yielding both empirical and modeled percentages above 60%. The items contribute to a lesser extent, with an eigenvalue of 3.6 and 14.7% variance explained, which is consistent across both empirical and modeled data. Notably, there remains a segment of the variance, quantified at 24.6% empirically and 24.9% modeled, that is unexplained by the analysis, indicating the potential influence of additional factors not encapsulated by the principal component. Furthermore, the first contrast leaves a variance of 7.5% empirically and a significantly higher modeled percentage of 30.5% unexplained, denoted by a lower eigenvalue of 1.8. This discrepancy necessitates further investigation but does not substantially detract from the overall unidimensional character of the data as revealed by the principal components.

**Table 5** *Digital pedagogy*

<b>Analysis Variants</b>	<b>Eigen Value</b>	<b>Empirical (%)</b>	<b>Modeled (%)</b>
Raw variance explained by measurements	18.4	75.4	75.1
Raw variance explained by respondents	14.8	60.6	60.4
Raw variance explained by items	3.6	14.7	14.7
The amount of raw variance is not explained	6.0	24.6	24.9
Variance is not explained in the first contrast	1.8	7.5	30.5

### 3.4 Assessment

Table 6 presented the principal component analysis that provides a discerning evaluation of the Assessment construct's dimensionality. The substantial eigenvalue of 16.2 for the variance explained by measurements, corresponding to 72.9% and 72.7% in empirical and modeled terms respectively, suggests a predominant unidimensional trait. This is indicative of a single construct predominantly governing the measurements within the analysis. Similarly, the variance explained by respondents, with an eigenvalue of 12.7, accounts for over half of the variance at 57.5% empirically and 57.3% in the modeled data, further affirming the unidimensionality of the construct as it pertains to respondent variance. The items themselves present an eigenvalue of 3.4, elucidating 15.5% of the variance empirically and 15.4% modeled. Although lower, this consistency across empirical and modeled data contributes to the evidence supporting a unidimensional structure. However, the analysis also highlights a non-negligible portion of unexplained variance, standing at 27.1% empirically and 27.3% in the modeled data, as indicated by an eigenvalue of 6.0. This suggests that while a significant majority of the variance is captured by a single dimension, there remains a portion that may be influenced by other latent factors or dimensions not captured by the primary analysis. Notably, the variance unexplained in the first contrast exhibits a marked contrast between the empirical (9.3%) and modeled (34.5%) data, with an eigenvalue of 2.1. This significant difference, particularly in the modeled data, suggests the potential existence of additional dimensions within the construct that the first contrast does not account for.

**Table 6** *Assessment*

<b>Analysis Variants</b>	<b>Eigen Value</b>	<b>Empirical (%)</b>	<b>Modeled (%)</b>
Raw variance explained by measurements	16.2	72.9	72.7
Raw variance explained by respondents	12.7	57.5	57.3
Raw variance explained by items	3.4	15.5	15.4
The amount of raw variance is not explained	6.0	27.1	27.3
Variance is not explained in the first contrast	2.1	9.3	34.5

### 3.5 Empowering Learners

Table 7 shows the results of the principal component analysis indicating a dominant unidimensional factor underpinning the digital competency construct, as evidenced by significant portions of variance being explained by measurements, respondents, and items, with respective eigenvalues of 15.9, 11.8, and 4.1. This factor accounts for 72.6% of the empirical and 72.4% of the modeled variance for measurements, 54.0% and 53.9% for respondents, and 18.6% and 18.5% for items, collectively suggesting a strong alignment with a single underlying construct. However, the presence of unexplained variance—27.4% empirically and 27.6% modeled—along with a substantial discrepancy in the first contrast (8.9% empirical versus 32.3% modeled unexplained variance) implies that there could be additional latent dimensions or factors influencing the framework that the primary factor does not fully encapsulate, signaling the need for further multidimensional exploration.

**Table 7 Empowering learners**

<b>Analysis Variants</b>	<b>Eigen Value</b>	<b>Empirical (%)</b>	<b>Modeled (%)</b>
Raw variance explained by measurements	15.9	72.6	72.4
Raw variance explained by respondents	11.8	54.0	53.9
Raw variance explained by items	4.1	18.6	18.5
The amount of raw variance is not explained	6.0	27.4	27.6
Variance is not explained in the first contrast	1.9	8.9	32.3

### 3.6 Facilitating Learners' Digital Competence

Table 8 delineates the results of the principal component analysis for Element 6, that concerned with Facilitating Learners' Digital Competence. Empirical measurements account for 82.6% of the raw variance, while the modeled data explains 81.3%, reflecting a strong unidimensional characteristic. The eigenvalue associated with the first contrast stands at 1.9, with a relatively small unexplained variance of 8.3% in the first contrast. These metrics collectively suggest that the construct of Facilitating Learners' Digital Competence predominantly operates within a single dimension.

**Table 8 Facilitate learners' digital**

<b>Analysis Variants</b>	<b>Eigen Value</b>	<b>Empirical (%)</b>	<b>Modeled (%)</b>
Raw variance explained by measurements	19.0	82.6	81.3
Raw variance explained by respondents	14.2	62.5	60.6
Raw variance explained by items	4.8	21.1	20.7
The amount of raw variance is not explained	4.0	17.4	18.7
Variance is not explained in the first contrast	1.9	8,3	47.5

### 3.7 Digital Environment

The results of the analysis as stated in Table 9 show the value of the percentage of raw variance explained by empirically based measurements for element 7 which is the Digital Environment is 66.3% and based on the model is 65.7%. The Eigen value of the first contrast is 2.3 and the percentage of unexplained variance in the first contrast is 15.6%. Based on the findings showing that the percentage of unexplained variance in the first contrast (first contrast unexplained variance) is more than 10 percent, then the Digital Environment element is not unidimensional.

**Table 9 Digital environment**

<b>Analysis Variants</b>	<b>Eigen Value</b>	<b>Empirical (%)</b>	<b>Modeled (%)</b>
Raw variance explained by measurements	9.8	66.3	65.7
Raw variance explained by respondents	7.5	50.6	50.1
Raw variance explained by items	2.3	15.7	15.5
The amount of raw variance is not explained	5.0	33.7	34.3
Variance is not explained in the first contrast	2.3	15.6	46.3

### 3.8 Extrinsic Digital Commitment

Table 10 shows the findings of the main component analysis of element 8 which is Extrinsic Digital Commitment. It was found that the raw variance explained by empirical measurement is 71.5% and modeled is 70.3%. The eigenvalue of the first contrast is 2.3 and the percentage of unexplained variance in the first contrast is 16.1%. This shows that the Extrinsic Digital Commitment element is not unidimensional.

**Table 10** *Extrinsic digital commitment*

<b>Analysis Variants</b>	<b>Eigen Value</b>	<b>Empirical (%)</b>	<b>Modeled (%)</b>
Raw variance explained by measurements	10.0	71.5	70.3
Raw variance explained by respondents	7.3	52.0	51.1
Raw variance explained by items	2.7	19.5	19.2
The amount of raw variance is not explained	4.0	28.5	29.7
Variance is not explained in the first contrast	2.3	16.1	56.6

The analysis of the digital competency framework reveals a discerning approach to component retention based on the extent of unexplained variance in the first empirical contrast. Elements with lower unexplained variances, such as Digital Resources, Digital Pedagogy, Assessment, Empowering Learners, and Facilitating Learners' Digital Competence (ranging from 7.5% to 9.3%), are retained, suggesting that these elements are consistent and reliable indicators of the construct being measured. Conversely, elements such as Professional Engagement, Digital Environment, and Extrinsic Digital Commitment, which exhibit higher unexplained variances (14.8% to 16.1%), are dropped from the framework. This exclusion indicates that these components may not align as effectively with the construct or could be influenced by external variables not considered within the model. This strategic selection process aims to enhance the framework's overall validity by focusing on the most stable and coherent elements of digital competency.

**Table 11** *Evaluation of retained and excluded digital competency elements for primary school design and technology educators*

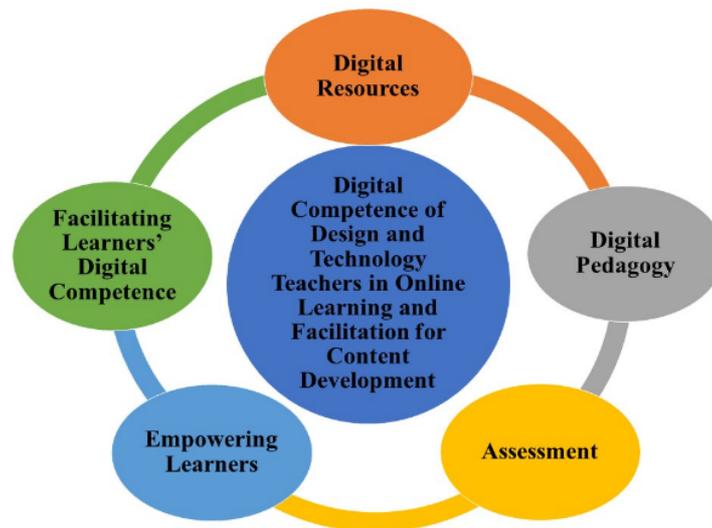
<b>Element</b>	<b>Variance is not explained in the first contrast Empirical (%)</b>	<b>Element Status</b>
Element 1: Professional Engagement	14.8	Drop
Element 2: Digital Resources	9.2	Remain
Element 3: Digital Pedagogy	7.5	Remain
Element 4: Assessment	9.3	Remain
Element 5: Empowering Learners	8.9	Remain
Element 6: Facilitating Learners' Digital Competence	8.3	Remain
Element 7: Digital Environment	15.6	Drop
Element 8: Extrinsic Digital Commitment	16.1	Drop

Table 11 presents the evaluation of retained and excluded digital competency elements for primary school Design and Technology educators based on the variance not explained in the first empirical contrast. Elements with lower unexplained variances, such as Digital Resources, Digital Pedagogy, Assessment, Empowering Learners, and Facilitating Learners' Digital Competence, are retained, suggesting these elements are consistent and reliable indicators of the construct being measured. Conversely, elements like Professional Engagement, Digital Environment, and Extrinsic Digital Commitment, which exhibit higher unexplained variances, are excluded from the framework. This exclusion indicates that these components may not align as effectively with the construct or could be influenced by external variables not considered within the model.

#### 4. Discussion

Referring to the study findings for the purpose of validating the digital competence framework for teachers, the researchers used Principal Component Analysis (PCA) as their method. According to Wright & B.D. (1996), using PCA in Factor Analysis ensures that the items measuring the elements are unidimensional. Before conducting PCA, the researchers reviewed the items to ensure that the values of PTMEA CORR. were positive, that the developed items were suitable (fit), and unidimensional with the model. This aligns with (Linacre & J.M., 2010) perspective, which recommends three levels of examination and data review to identify unidimensionality, namely by reviewing (i) PTMEA CORR values; (ii) item fit; and (iii) the results of Principal Component Analysis (PCA). The study proved that there are some items that were produced and the research elements that were formed met the criteria of the Rasch Model. The analysis results using Principal Component Analysis (PCA) dimensionality review

demonstrate that only elements 2 Digital Resources, element 3 Digital Pedagogy, element 4 Assessment, element 5 Empowering Students, and element 6 Facilitating Student Digital Competence within the teacher's digital competence framework are unidimensional, meaning there are no other dimensions or factors that can influence them. Based on the study's analysis results, elements 1 Professional Engagement, element 7 Digital Environment, and element 8 Extrinsic Digital Commitment failed to meet the factor analysis criteria based on the Rasch model. Therefore, these three elements are not unidimensional. The digital competence framework diagram specifically designed for primary school DT teachers, like Figure 1, can serve as a guide and reference for primary school DT teachers, teacher trainees opting for DT subjects in developing online teaching and facilitation content as well as the Ministry of Education in policymaking for planning, designing, and implementing in-service training for the development of teacher digital competence.



**Fig. 1** A new digital competency framework for primary school design and technology teachers

In the framework of digital competence for primary school DT teachers, the primary school DT teachers in the state of Johor believe that the required digital competence elements for the development of online teaching and facilitation content are Digital Resources, Digital Pedagogy, Assessment, Empowering Learners, and Facilitating Learners' Digital Competence. In the era of globalization and technological advancement, digital competence has become crucial for educators, including DT teachers in primary schools. For primary school DT teachers in the state of Johor, they are convinced that there are five digital competence elements that are highly important to be developed in online teaching and facilitation content. These five elements are Digital Resources, Digital Pedagogy, Assessment, Empowering Learners, and Facilitating Learners' Digital Competence.

Digital Resources refer to various tools, materials, and electronic resources available and used to support online learning processes (Ngozi et al., 2020). This includes e-books, e-journals, instructional videos, learning platforms, and other multimedia resources. DT teachers need to have the ability to search, select, and use these digital resources effectively according to the learning objectives. Additionally, teachers should ensure that the digital resources used are reliable and relevant to ensure quality in online teaching and facilitation content. Digital Pedagogy encompasses strategies, methodologies, and teaching approaches that integrate digital technology into the learning process (Vääätäjä & Ruokamo, 2021). DT teachers need to develop the ability to design and deliver instruction that focuses on the use of information and communication technology to enhance interaction, engagement, and understanding among students. In the context of online learning, teachers must be capable of using the right technology tools and platforms to provide interactive, collaborative, and in-depth learning experiences.

Assessment in the context of DT teacher digital competence involves evaluating students' skills and knowledge related to the use of digital technology. Teachers need to develop various forms of assessment that cover aspects of digital competence, such as the ability to search for information online, digital information analysis skills, effective communication through digital media, and so on (Sillat et al., 2021). Assessment should also include measuring students' progress in developing digital competence over time.

One of the primary goals of learning with a digital competence approach is to Empower Learners to manage and optimize the use of technology in their everyday learning processes. DT teachers should encourage students to become independent and active learners in using technology to seek information, learn, communicate, and solve

problems. This can be achieved through project-based learning, open discussions, and providing opportunities for students to be creative and innovative using technology.

The last element is Facilitating Learners' Digital Competence, which means facilitating or enabling students to develop their digital competence. DT teachers should create a learning environment that supports the effective and efficient use of technology. This includes providing access to adequate devices and internet connections, offering appropriate guidance and support in addressing technological challenges, and creating a safe and inclusive learning atmosphere for all students.

## 5. Conclusion

In summary, the integration of five critical elements—Digital Resources, Digital Pedagogy, Assessment, Empowering Students, and Facilitating Student Digital Competence—into the digital competence framework for Design and Technology (DT) teachers is projected to significantly enhance the quality of online instruction and facilitation within Johor's primary education sector. By strategically employing digital tools, educators can create an interactive, comprehensive, and progressive learning environment that not only meets but anticipates the educational demands and opportunities of the digital age.

This enhanced digital proficiency among both educators and students is a crucial step toward developing a digitally skilled and competitive community. The inclusion of these core aspects of digital competence allows DT teachers to craft a learning experience that is both modern and engaging for students who are digital natives. This approach not only prepares learners to skilfully navigate but also to thrive in a global society and labor market that are increasingly digitalized.

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## Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

## Author Contribution

*The authors confirm contribution to the paper as follows: Validation of Digital Competence Framework for Primary School Design and Technology Teachers Using Rasch Model: C H Go, M Z ;Rozali data collection: C H Go; analysis and interpretation of results: C H Go, M Z ;Rozali, Mohd Samshul S N ; draft manuscript preparation: C H Go, M Z ;Rozali , Zakaria, A. F. All authors reviewed the results and approved the final version of the manuscript.*

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