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Situational Judgement Test (SJT) on Digital Leadership using Fuzzy Delphi Method for Expert Evaluations

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Abstract

Nowadays, one of the most prominent leadership philosophies is digital leadership. However, there are still few tools available to assess digital leadership. Unfortunately, the discussion about expert consensus items is limited, especially involving fuzzy considerations. Therefore, this study will assess the content validity of an instrument called situational judgement test (SJT) by using Fuzzy Delphi Method (FDM). There are 13 panels chosen to serve as the FDM's experts. The item should satisfy three conditions of FDM, namely the threshold value (d), the percentage of expert consensus, and the fuzzy score (Amax). The questionnaire uses a seven-point Likert scale based on appropriateness. There are nine constructs, namely (1) Student Engagement, Learning, and Outcomes; (2) Learning Environment and Spaces; (3) Professional Growth and Learning; (4) Communication; (5) Public relations; (6) Branding; (7) Opportunities; (8) Empowered Professionals; and (9) Learning Catalyst. Each construct has 10 items at the first level. According to the results of the study, only 45 of 90 items are appropriate for inclusion in the SJT to assess teachers' digital leadership roles, i.e., five items for each construct. The findings have important implications to recommend any other empirical ways of assessing SJT items to increase the validity aspect of the items.

Keywords: *Situational Judgement Test, Digital Leadership, Content Validity, Fuzzy Delphi Method, Teacher.*

INTRODUCTION

Digital leadership refers to leadership that involves the use of modern technology (AlAjmi, 2022; Karakose et al., 2021). Digital leadership is the process of looking for novel uses of technology and putting new concepts into practise in adaptable and original ways (Avidov-Ungar et al., 2022). In education, digital leadership is the skill of leading, influencing others, bringing about sustainable change through information access, and developing connections to foresee developments that will be crucial to future school success (Agustina et al., 2020; Karakose et al., 2021). Digital leadership demands current organisational, pedagogical, and technological understanding (Avidov Ungar & Shamir-Inbal, 2017). Digital leadership has a big impact on how well teachers adopt and use digital technologies (Sunu, 2022).

There are a number of constructs that can be used to gauge teachers' digital leadership. Sheninger (2019) and the International Society for Technology in Education (2017) are two sources that are used to describe the conceptions of digital leadership in this study. According to Sheninger (2019), there are seven pillars of digital leadership: opportunity, learning environment and spaces, public relations, student engagement, learning and outcomes, professional growth and learning, and public relations. The empowered professional and learning catalyst are two key constructs for educators, according to International Society for Technology in Education (2017). The common assessment tool used in measuring digital leadership is questionnaire. However, in this study, an instrument called situational judgement test (SJT) is employed to gauge digital leadership among teachers.

The SJT method's main component is to give test takers a set of scenarios that, when presented in a standardised format, depict normal and/or important work-related circumstances (Reiser et al., 2022). The scenarios typically end at a crucial moment, and the test takers must assess various answer alternatives that provide alternate ways to move further in the scenario (Whetzel et al., 2020). Depending on the assessment

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objective, many evaluation forms for the answer choices are possible, such as selecting the best option, ranking possibilities, or assessing their effectiveness in relation to a goal (Arthur et al., 2014). To evaluate the content validity of the SJT items, this study uses the Fuzzy Delphi Method (FDM).

The FDM's effectiveness in the validation process, particularly the expert validation process, cannot be disputed (Mustapha et al., 2022). FDM is used in this study to prioritise expert consensus while determining the investigation's findings (Mohd Khalli et al., 2022). Due to the inherent ambiguity in expert assessments that causes uncertainty, FDM was deemed practical for the contemplated expedition (Lin & Wang, 2022). In FDM, triangular fuzzy numbering (triangular fuzzy number) was used to evaluate data, and the defuzzification method was used to identify each variable's position (ranking) (Mustapha et al., 2022). The paper structure has the Methodology, Results and Discussion, Conclusion, and the Limitation.

METHODOLOGY

This section will explain on sampling and participants, instrument, procedure of FDM, and analysis of the data.

Sampling and Participants

In this study, a purposive sampling method is used to select FDM panels. A technique known as purposeful sampling admits that researchers select individuals using their own skills and judgement (Zickar & Keith, 2023). Expert sampling is one of the purposive sampling variations where participants may be chosen based on their specific skill or knowledge in the issue of interest (Etikan et al., 2016). This panel consists of university lecturers in leadership and ministry staff with a background in leadership, digital technology, and digital leadership. The validity of the study is compromised if the experts selected lack sufficient expertise in the studied subjects (Zulkifli et al., 2022). Their feedback is crucial in establishing whether the questionnaire's items are appropriate for gauging teachers' digital leadership. All 13 experts agreed to serve on the FDM panel. Table 1 shows list of participants, their expertise and place of work.

Table 1: List of the Participants

No.	Participant	Expert Field	Place of Work
1	A001	Leadership	Universiti Putra Malaysia
2	A002	Leadership	Universiti Pendidikan Sultan Idris
3	A003	Leadership	Universiti Kebangsaan Malaysia
4	A004	Leadership	Universiti Pendidikan Sultan Idris
5	A005	Leadership	Universiti Tun Hussein Onn Malaysia
6	A006	Leadership	Universiti Malaysia Perlis
7	A007	Leadership	Universiti Teknologi Malaysia
8	A008	Digital technology	Ministry of Education Malaysia
9	A009	Digital leadership	Ministry of Finance Malaysia
10	A010	Leadership	Universiti Tun Hussein Onn Malaysia
11	A011	Digital leadership	Ministry of Education Malaysia
12	A012	Digital leadership	Universiti Teknologi Malaysia
13	A013	Leadership	Universiti Teknologi Mara

Instrument

In the SJT, 90 items are first listed. Each item has a situation and four potential responses. These 90 elements were included in a questionnaire at the beginning of the FDM process for expert review. The questionnaire comprises nine constructs, each of which has 10 items. The nine constructs namely (1) Student engagement, learning, and outcomes; (2) Learning environment and spaces; (3) Professional growth and learning; (4) Communications; (5) Public relations; (6) Branding; (7) Opportunity; (8) Empowered professional; and (9) Learning catalyst. The questionnaire uses a seven-point Likert scale based on appropriateness. Each level in Likert will be transformed into Fuzzy scale. The more points on the scale, the more precise and accurate the data is (Abdul Ghani et al., 2021).

Procedure of FDM

The following are the four steps in FDM:

Step One: Choosing the Experts: 13 experts in all were chosen to respond to the questionnaire.

Step Two: Selection of the Linguistic Scale: The explanation of the appropriateness level for the seven Likert scales and Fuzzy scale is shown in Table 2 (Mohd Jamil & Mat Noh, 2021). Next, the data were scheduled to produce fuzzy values (n_1, n_2, n_3) and fuzzy average values (m_1, m_2, m_3) in order to provide threshold values, expert consensus rates, defuzzification, and item rankings (Abdul Ghani et al., 2021).

Table 2: Appropriateness Level of Seven-Point Scale

Likert Scale	Appropriateness Level	Fuzzy Scale		
		m_1	m_2	m_3
1	Extremely inappropriate	0.0	0.0	0.1
2	Strongly inappropriate	0.0	0.1	0.3
3	Inappropriate	0.1	0.3	0.5
4	Moderately appropriate	0.3	0.5	0.7
5	Appropriate	0.5	0.7	0.9
6	Strongly appropriate	0.7	0.9	1.0
7	Extremely appropriate	0.9	1.0	1.0

Step Three: Find the Average or Threshold Value (d): The value of d served as the threshold value according to the calculation in Figure 1. The threshold value should not be greater than 0.2 in an effort to reach expert agreement on each item (Abdul Ghani et al., 2021). If the result was d 0.2, then there was consensus among all experts regarding the subject (Abdul Ghani et al., 2021). But if it didn't, a second round would need to be conducted to determine whether or not the item was necessary (Chen, 2000; Cheng & Lin, 2002). The formula for determining the distance between two fuzzy numbers:

$$d(\tilde{m},\tilde{n}) = \sqrt{\frac{1}{3}[(m_1 - n_1)^2 + (m_2 - n_2)^2 + (m_3 - n_3)^2]} \quad \ldots (1)$$

The Fuzzy Delphi technique also entailed figuring out if the expert consensus surpassed or was equal to 75 percentage for the overall construct or for each individual item (Abdul Ghani et al., 2021). If the proportion of expert consensus for an item was equal to or more than 75 percent, it was assumed that the item had reached expert consensus (Chu & Hwang, 2008; Murray et al., 1985).

Step Four: Process of Defuzzification: The value of defuzzification for each item should be greater than α-cut = 0.5 (Abdul Ghani et al., 2021). Defuzzification is the process of figuring out where each thing should be placed in relation to other items, or where each variable or sub-variable should be (Mohd Jamil & Mat Noh, 2021).

Analysis of the Data

This FDM was analysed using a Microsoft Excel template. Based on the template, the first step is to enter a Likert scale value for each item selected by the FDM panel. The scale value ranges from 1 to 7. Then, the template is processed to find the average fuzzy value (m_1, m_2, m_3) of the fuzzy scale. Then, the threshold value (d) is determined, and the value of d must be $\leq$ 0.2. Then, the percent agreement for each item and for all items is determined. The condition that must be met is the percentage value obtained for each item $\geq$ 75 percent. The last step is the process of defuzzification. There are three formulas that are used to determine the ranking or score of the item, namely:

$A_{max} = 1/3 * (m_1 + m_2 + m_3)$ ……(2)

$A_{max} = 1/4 * (m_1 + m_2 + m_3)$ ……(3)

$A_{max} = 1/6 * (m_1 + m_2 + m_3)$ ……...…… (4)

RESULTS AND DISCUSSION

The items in each construct are evaluated in pairs. It is because each pair consists of a question and choices of answers, considering that the instrument being assessed is SJT and not a questionnaire using a Likert scale. For each situation and possible actions to be selected, there are three conditions that should be met, namely (i) the threshold value (d) is $\leq$ 0.2, (ii) the percentage of expert consensus is $\geq$ 75 percent, and (iii) the fuzzy

score (A_{max}) $\geq$ 0.5. Table 3 shows the threshold value, expert consensus percentage, defuzzification, and expert agreement decision on student engagement, learning, and outcomes. Although there are 10 items for each construct, the best five items for each construct are selected in this study.

Table 3: Findings of Threshold Values, Expert Consensus Percentage, Defuzzification, Expert Agreement Decision and Final Decision on Student Engagement, Learning, and Outcomes

Item	Triangular Fuzzy Number Requirements				Fuzzy Evaluation	Expert Agreement Decision	Final Decision
	Threshold Value (d)	Average of Threshold Value (d)	Expert Consensus Percentage (%)	Average of Expert Consensus Percentage (%)	Defuzzification (A_{max})		
1	0.225	0.226	46	42	0.797	Reject	Reject
1a	0.226		38		0.818	Reject	
2	0.255	0.275	38	42	0.803	Reject	Reject
2a	0.294		46		0.762	Reject	
3	0.146	0.207	69	54	0.854	Reject	Accept
3a	0.268		38		0.733	Reject	
4	0.183	0.263	69	39	0.846	Reject	Reject
4a	0.342		8		0.736	Reject	
5	0.207	0.216	46	46	0.823	Reject	Accept
5a	0.224		46		0.821	Reject	
6	0.238	-	77	-	0.844	Reject	Accept
6a	0.183		85		0.879	Accept	
7	0.359	0.388	31	20	0.764	Reject	Reject
7a	0.417		8		0.728	Reject	
8	0.262	0.353	77	43	0.846	Reject	Reject
8a	0.444		8		0.708	Reject	
9	0.174	-	77	-	0.882	Accept	Accept
9a	0.228		69		0.854	Reject	
10	0.139	-	77	-	0.882	Accept	Accept
10a	0.218				0.872	Reject	

Notes: *the (-) represents the accepted pair of items as either one of the situations or possible actions meets the three conditions of FDM.*

The items selected for the construct of student engagement, learning, and outcomes are item 3 and 3a, item 5 and 5a, item 6 and 6a, item 9 and 9a, and item 10 and 10a. One of the situations or set of actions for item 6 and 6a, item 9 and 9a, item 10 and 10a meets the conditions of the FDM. This results in item 6, item 9, and item 10 being accepted in this construct. The remaining items had a threshold greater than 0.2. However, item 3 and item 5 were selected because both items had the lowest mean of the threshold value and the highest mean of expert consensus percentage between the situations and possible actions.

This construct also includes items related to student engagement and learning. The situations represented in the five selected items relate to computer use, soft copy materials storage, control of classroom device use, lack of digital devices, and use of online applications. Possible actions that should be taken by teachers who have good digital leadership must lead to the use of digital technology. In addition, the right responses must show that the teacher is able to lead students in a way that achieves learning objectives, such as through creative solution finding. Teachers must also be flexible in teaching solutions that are appropriate to the students' level and abilities so as not to overwhelm the students.

As technology changes, pedagogy and instructional design must also change to ensure the effectiveness of learning with digital technology. According to the theory of experiential learning, students must go through all phases of the learning process, namely experience, reflection, thinking, and doing (Conole et al., 2004; Kolb & Kolb, 2009). Therefore, in digital leadership, it is important to familiarise students with digital technology while teachers use the appropriate elements in the teaching and learning process. Table 4 shows the threshold value, expert consensus percentage, defuzzification, and expert agreement decision on learning environment and spaces.

Table 4: Findings of Threshold Values, Expert Consensus Percentage, Defuzzification, Expert Agreement Decision and Final Decision on Learning Environment and Spaces

Item	Triangular Fuzzy Number Requirements				Fuzzy Evaluation	Expert Agreement Decision	Final Decision
	Threshold Value (d)	Average of Threshold Value (d)	Expert Consensus Percentage (%)	Average of Expert Consensus Percentage (%)	Defuzzification (A_{max})		
1	0.116	0.186	85	85	0.910	Accept	Accept
1a	0.256		85		0.831	Reject	
2	0.172	0.276	77	46	0.874	Accept	Reject
2a	0.379		15		0.710	Reject	
3	0.280	-	31	-	0.810	Reject	Reject
3a	0.344		15		0.715	Reject	
4	0.148	-	85	-	0.895	Accept	Accept
4a	0.145		85		0.903	Accept	
5	0.139	0.273	77	46	0.882	Accept	Reject
5a	0.406		15		0.659	Reject	
6	0.172	0.224	77	58	0.874	Accept	Reject
6a	0.275		38		0.803	Reject	
7	0.148	0.193	85	66	0.895	Accept	Accept
7a	0.238		46		0.808	Reject	
8	0.148	0.212	85	62	0.895	Accept	Reject
8a	0.275		38		0.803	Reject	
9	0.148	0.186	85	77	0.895	Accept	Accept
9a	0.224		69		0.846	Reject	
10	0.145	-	85	-	0.903	Accept	Accept
10a	0.172		77		0.874	Accept	

Notes: the (-) represents both accepted situations and possible actions in a pair of items as they meet three conditions of FDM or rejected due to not complying with three conditions of FDM.

After reviewing the results of the FDM analysis for the construct of learning environment and spaces, the accepted items are 1, 4, 7, 9, and 10. However, only item 4 and 4a and item 10 and 10a meet the three FDM requirements, namely (i) threshold value (d) ≤ 0.2, (ii) expert group agreement ≥ 75 percent, and (iii) fuzzy score (A_{max}) ≥ 0.5. Therefore, three more items are needed, namely the third, fourth, and fifth items.

Item 3 should not be selected because the situation and action set do not meet the requirements of the FDM. Therefore, the selection method is to compare the average threshold value (d), and average expert agreement for the situation and action set for the remaining items. Item 2 and 2a, item 5 and 5a, item 6 and 6a, and item 8 and 8a were found to have an average threshold value (d) greater than 0.2. Therefore, these four item pairs are not selected for this construct.

Item 1 and 1a, item 7 and 7a, and item 9 and 9a have an average threshold value (d) of less than 0.2 and can be considered for this construct. Also, on the basis of average expert agreement, item 1 and 1a, and Item 9 and 9a are above 75 percent. Therefore, both items are accepted for the construct. However, the mean expert agreement for item 7 is 66 percent. Although the value is below 75 percent, it still exceeds 50 percent, which is accepted by half of the FDM panels. Therefore, item 7 was also selected for this construct.

In this construct, the selected items relate to the provision of digital devices needed by teachers to design teaching and learning processes. Then, the learning environment disrupts student focus and damage to equipment that hinders exposure to teaching materials. Other items touch on limited learning space in addition to an appropriate medium for storing many student assignments. In connectivism learning theory, one of the important features is a technology-assisted environment that supports meaningful dialogue and collaboration (Kizito, 2016).

As someone who has good digital leadership, teachers need to be wise in planning the use of digital tools if their supplies are limited, varying teacher pedagogies, solving issues according to established procedures, carefully making decisions and leading students in carrying out innovations. As emphasized by Sheninger (2019), the emphasis in this construct is integrating technology to engage students and make learning fun. Table 5 shows the threshold value, expert consensus percentage, defuzzification, and expert agreement decision on professional growth and learning.

Table 5: Findings of Threshold Values, Expert Consensus Percentage, Defuzzification, Expert Agreement Decision and Final Decision on Professional Growth and Learning

Item	Triangular Fuzzy Number Requirements				Fuzzy Evaluation	Expert Agreement Decision	Final Decision
	Threshold Value (d)	Average of Threshold Value (d)	Expert Consensus Percentage (%)	Average of Expert Consensus Percentage (%)	Defuzzification (A_{max})		
1	0.237	0.285	77	61.5	0.846	Reject	Accept
1a	0.333		46		0.754	Reject	
2	0.148	-	85	-	0.887	Accept	Accept
2a	0.212		85		0.851	Reject	
3	0.302	0.285	31	31	0.808	Reject	Reject
3a	0.267		31		0.823	Reject	
4	0.111	-	85	-	0.918	Accept	Accept
4a	0.237		77		0.846	Reject	
5	0.270	0.280	77	54	0.831	Reject	Accept
5a	0.289		31		0.815	Reject	
6	0.234	-	77	-	0.836	Reject	Accept
6a	0.182		85		0.872	Accept	
7	0.302	0.343	38	23	0.782	Reject	Reject
7a	0.384		8		0.744	Reject	
8	0.238	0.270	54	42.5	0.810	Reject	Reject
8a	0.302		31		0.808	Reject	
9	0.244	0.260	46	42	0.818	Reject	Reject
9a	0.275		38		0.803	Reject	
10	0.275	0.291	38	38	0.803	Reject	Reject
10a	0.307		38		0.787	Reject	

Notes: the (-) represents the accepted pair of items as either one of the situations or possible actions meets the three conditions of FDM.

After reviewing the results of the FDM analysis for the learning and professional development construct, the five accepted items are item 1, 2, 4, 5, and 6. Item 2, 4, and 6 are accepted because one of the situations or a set of actions meets all three FDM requirements, namely (i) threshold value (d) ≤ 0.2, (ii) expert panel agreement ≥ 75 percent, and (iii) fuzzy score (A_{max}) ≥ 0.5. Therefore, two more items are needed as the fourth and fifth items.

However, item 1 and 1a, 3 and 3a, 5 and 5a, 7 and 7a, 8 and 8a, 9 and 9a, and 10 and 10a are not suitable for FDM. Therefore, the selection method is to compare the average threshold value (d), and the average agreement of the experts on the situation and the set of action for the seven items in question. These seven items had an average threshold value (d) greater than 0.2.

Therefore, the selection method refers to the experts' average agreement for the situation and the set of action for the seven items concerned. Item 3, 7, 8, 9, and 10 were not to be accepted because the average agreement of the experts for the situation and set of action is less than 50 percent i.e., they received less than half of the agreement of the FDM panel. Therefore, item 1 and 5 were selected because the average agreement of the experts for the situations and action sets was 61.5 percent and 54 percent, respectively.

The situations for the five items selected for this construct relate to how to make changes in report submissions, how to design ways to store lecture materials and conduct briefings, how to inspire colleagues, and how to influence colleagues toward digital technology. Possible actions suggested including using the website, using the cloud, and using an online platform, the teacher needs to be a role model for colleagues and guide friends in using messaging applications. Leaders need to and should be aware of the latest trends, research, and ideas in their respective fields. As Sheninger (2019) suggests, teachers can use social media such as educational blogs and Twitter as a tool for developing professional practice. Table 6 shows the threshold value, expert consensus percentage, defuzzification, and expert agreement decision on communication.

Table 6: Findings of Threshold Values, Expert Consensus Percentage, Defuzzification, Expert Agreement Decision and Final Decision on Communication

Item	Triangular Fuzzy Number Requirements	Fuzzy Evaluation	Expert	Final

	Threshold Value (d)	Average of Threshold Value (d)	Expert Consensus Percentage (%)	Average of Expert Consensus Percentage (%)	Defuzzification (A_{max})	Agreement Decision	Decision
1	0.117	0.168	85	77	0.895	Accept	Accept
1a	0.219		69		0.838	Reject	
2	0.119	-	85	-	0.903	Accept	Accept
2a	0.148		85		0.895	Accept	
3	0.148	0.208	85	58	0.887	Accept	Reject
3a	0.267		31		0.823	Reject	
4	0.237	-	77	-	0.846	Reject	Reject
4a	0.281		46		0.800	Reject	
5	0.119	0.233	85	54	0.903	Accept	Reject
5a	0.346		23		0.767	Reject	
6	0.260	-	77	-	0.838	Reject	Reject
6a	0.360		38		0.767	Reject	
7	0.148	-	85	-	0.895	Accept	Accept
7a	0.148		85		0.887	Accept	
8	0.204	0.189	77	77	0.859	Reject	Accept
8a	0.174		77		0.882	Accept	
9	0.204	-	77	-	0.859	Reject	Reject
9a	0.200		77		0.851	Reject	
10	0.111	0.165	85	77	0.918	Accept	Accept
10a	0.219		69		0.838	Reject	

Notes : the (-) represents both accepted situations and possible actions in a pair of items as they meet three conditions of FDM or rejected due to not complying with three conditions of FDM.

After examining the results of the FDM analysis for the communication construct, the five items obtained are 1, 2, 7, 8, and 10. However, only item 2 and 2a and 7 and 7a meet the three FDM conditions, namely (i) threshold value (d) ≤ 0.2, (ii) expert panel agreement ≥ 75 percent, and (iii) fuzzy score (A_{max}) ≥ 0.5. Therefore, three more situations and sets of action are needed as the third, fourth, and fifth items.

Item 4, 6, and 9 should not be selected because both the situation and set of action do not meet the requirements of the FDM. Item 1, 3, 5, 8, and 10, on the other hand, can be considered because one of the situations or set of action area meets the three requirements of the FDM. The average threshold value (d) ≤ 0.2 and the average expert agreement for the situation and action set ≥ 75 percent are used as the selection method. Item 1, 8, and 10 are accepted because the average threshold values (d) are 0.168, 0.189, and 0.165, respectively, and the mean expert agreement for the three items is 77 percent.

Examples of situations in this construct include how to communicate effectively when sharing expertise, how to improve communication with students in the classroom via online learning, how to deliver teaching and learning smoothly, how to communicate to solve problems, and how to find solutions related to disobedient students. There are some solutions to these situations, such as organizing online courses, sharing links to online platforms, finding appropriate solutions, and guiding colleagues in using appropriate, freely available applications.

Communication helps complete and prepare tasks, obtain, and communicate important information, promote a shared vision and mission, make decisions by consensus, maintain relationships, and encourage people to accept change (Sheninger, 2019). Communication theory often refers to three things, sender, message, and receiver (Mowlana, 2018). Based on the five-dimensional model of communication, communication with technology means that technology and communication equipment can be used to facilitate human communication (Mowlana, 2018). Table 7 shows the threshold value, expert consensus percentage, defuzzification, and expert agreement decision on public relations.

Table 7: Findings of Threshold Values, Expert Consensus Percentage, Defuzzification, Expert Agreement Decision and Final Decision on Public Relations

Item	Triangular Fuzzy Number Requirements				Fuzzy Evaluation	Expert Agreement Decision	Final Decision
	Threshold Value (d)	Average of Threshold	Expert Consensus	Average of Expert	Defuzzification (A_{max})		

		Value (d)	Percentage (%)	Consensus Percentage (%)			
1 1a	0.091 0.095	-	92 92	-	0.923 0.915	Accept Accept	Accept
2 2a	0.091 0.205	0.148	92 77	85	0.923 0.859	Accept Reject	Accept
3 3a	0.091 0.172	-	92 77	-	0.923 0.874	Accept Accept	Accept
4 4a	0.182 0.262	0.222	85 31	58	0.879 0.810	Accept Reject	Reject
5 5a	0.111 0.256	0.184	85 77	81	0.918 0.831	Accept Reject	Accept
6 6a	0.153 0.313	0.233	92 23	58	0.900 0.821	Accept Reject	Reject
7 7a	0.153 0.216	0.185	92 85	89	0.900 0.856	Accept Reject	Reject
8 8a	0.095 0.119	-	92 85	-	0.915 0.903	Accept Accept	Accept
9 9a	0.213 0.311	-	85 31	-	0.849 0.813	Reject Reject	Reject
10 10a	0.237 0.285	-	85 38	-	0.844 0.808	Reject Reject	Reject

Notes: the (-) represents both accepted situations and possible actions in a pair of items as they meet three conditions of FDM or rejected due to not complying with three conditions of FDM.

After examining the results of the FDM analysis for the construct of public relations, the five item 1, 2, 3, 5, and 8 were obtained. However, only item 1 and 1a, 3 and 3a, and 8 and 8a met the three FDM requirements, namely (i) threshold value (d) ≤ 0.2, (ii) expert group agreement ≥ 75 percent, and (iii) fuzzy score (A_{max}) ≥ 0.5. Therefore, two items are needed as the fourth and fifth items. Item 9 and 10 should not be selected because the situation and set of action for both do not meet the requirements of the FDM. Item 2, 4, 5, 6, and 7, on the other hand, can be considered because one of the situations or set of action meets the three FDM requirements. The selection method is to consider the average threshold value (d) ≤ 0.2 and the average expert agreement for the situation and the set of action ≥ 75 percent. Item 2 and 5 were accepted because the mean threshold values (d) for situation and set of action were 0.148 and 0.184, respectively, and the mean expert agreement between situation and set of action were 85 percent and 81 percent, respectively.

There are several examples of situations that fit this construct. These include sharing information with school members, including parents, distributing information about training, influencing friends to use digital technologies, implementing networking programs, promoting foreign language learning in schools, encouraging students to become informed, publicizing an event to the public, and taking action to promote an event.

A teacher who has good digital leadership skills will tend to use digital technologies, even in situations involving public relations. Therefore, the use of messaging applications such as WhatsApp and Telegram is often an option, depending on the objectives of the actions carried out. Teachers who have good digital leadership also need to be an example to other teachers and tend to choose social media as a platform for leading with digital technology.

As Sheninger (2019) explains, leaders can use free social media tools to create a positive platform for public engagement and become a source of news for the school or district. Public relations via social media is important to cultivate and foster relationships, engage people near and far in discussions about school issues, and allow everyone to have their say, i.e., students to teachers, teachers to administrators, and ultimately administrators to community. Table 8 shows the threshold value, expert consensus percentage, defuzzification, and expert agreement decision on branding.

Table 8: Findings of Threshold Values, Expert Consensus Percentage, Defuzzification, Expert Agreement Decision and Final Decision on Branding

Item	Triangular Fuzzy Number Requirements		Fuzzy Evaluation	Expert	Final
	Threshold Value (d)	Expert Consensus Percentage	Defuzzification	Agreement	Decision

		(%)	(A_{max})	Decision	
1	0.139	77	0.882	Accept	Reject
1a	0.391	15	0.695	Reject	
2	0.182	85	0.872	Accept	Reject
2a	0.311	31	0.813	Reject	
3	0.095	92	0.915	Accept	Accept
3a	0.116	85	0.910	Accept	
4	0.146	85	0.879	Accept	Accept
4a	0.096	92	0.908	Accept	
5	0.139	77	0.882	Accept	Accept
5a	0.148	85	0.887	Accept	
6	0.251	85	0.844	Reject	Reject
6a	0.215	85	0.859	Reject	
7	0.217	85	0.867	Reject	Reject
7a	0.240	77	0.854	Reject	
8	0.157	92	0.885	Accept	Accept
8a	0.191	92	0.879	Accept	
9	0.182	85	0.872	Accept	Reject
9a	0.286	31	0.821	Reject	
10	0.179	85	0.864	Accept	Accept
10a	0.179	85	0.864	Accept	

The items selected for the construct of branding are item 3 and 3a, item 4 and 4a, item 5 and 5a, item 8 and 8a, and item 10 and 10a. All five situations and possible responses meet three conditions of the FDM: (i) the threshold value is ≤ 0.2, (ii) the expert group consensus value ≥ 75 percent, and (iii) the fuzzy score value (A_{max}) ≥ 0.5.

Situations relevant to this branding construct are relationships, support and involvement of teachers and parents, increase in student achievement, introduction of the school to the public or surrounding communities, changes and improvements in teaching and learning processes that spark student interest, student enthusiasm for achievement, methods of fundraising for student activities, and sharing of new teaching techniques and activities.

To solve the dilemma in the present situation, the teacher will use the messaging application. In addition, the use of interesting educational applications helps teaching and learning, such as quizzes, and shows interactive videos and animations. Social media platforms are one of the alternatives chosen in branding constructs such as YouTube and TikTok.

As Sheninger (2019) explains, branding is all about building strong relationships with school stakeholders. Teachers can develop their own professional brand personas as well as the school by building relationships that lead to school improvement. Leaders can leverage the influence of social media to build a brand that highlights the positive aspects of the school culture, reinforces a sense of community pride, and encourages family members to send their children to school. Leaders need to communicate information to build strong relationships and promote learning. Table 9 shows the threshold value, expert consensus percentage, defuzzification, and expert agreement decision on opportunity.

Table 9: Findings of Threshold Values, Expert Consensus Percentage, Defuzzification, Expert Agreement Decision and Final Decision on Opportunity

Item	Triangular Fuzzy Number Requirements				Fuzzy Evaluation	Expert	Final
	Threshold Value (d)	Average of Threshold	Expert Consensus	Average of Expert	Defuzzification (A_{max})	Agreement Decision	Decision

		Value (d)	Percentage (%)	Consensus Percentage (%)			
1	0.095	0.104	92	89	0.915	Accept	Accept
1a	0.113		85		0.887	Accept	
2	0.157	-	92	-	0.885	Accept	Reject
2a	0.358		31		0.787	Reject	
3	0.082	-	92	-	0.931	Accept	Reject
3a	0.228		92		0.831	Reject	
4	0.123	-	92	-	0.892	Accept	Reject
4a	0.370		23		0.777	Reject	
5	0.248	-	85	-	0.836	Reject	Reject
5a	0.315		46		0.792	Reject	
6	0.182	0.153	85	89	0.872	Accept	Accept
6a	0.123		92		0.892	Accept	
7	0.082	0.177	92	92	0.931	Accept	Reject
7a	0.095		92		0.915	Accept	
8	0.117	0.120	92	92	0.915	Accept	Accept
8a	0.122		92		0.908	Accept	
9	0.153	0.168	92	89	0.900	Accept	Accept
9a	0.182		85		0.872	Accept	
10	0.148	0.148	85	85	0.895	Accept	Accept
10a	0.148		85		0.887	Accept	

Notes: the (-) represents the rejected pair of items as either one of the situations or possible actions did not meet the three conditions of FDM. The (-) also represents both rejected situations and possible actions in a pair of items due to not complying with three conditions of FDM.

After examining the results of FDM analysis for the opportunity construct, the five obtained items are 1, 6, 8, 9, and 10, which is because they meet the three FDM conditions, namely (i) threshold value (d) ≤ 0.2, (ii) expert group agreement ≥ 75 percent, and (iii) fuzzy score (A_{max}) ≥ 0.5. Although the situation and action set of action 7 also met the FDM requirements, the highest threshold value (d), 0.177, was obtained compared with the other five items. Therefore, item 7 is not accepted.

This construct has several related situations. These include implementing high-impact projects such as professional mentoring, opportunities to improve student performance using digital technologies, creating a learning environment that sparks student interest and enthusiasm, strengthening clubs in the school, and opportunities to develop relationships with outside organizations through programs such as corporate social responsibility (CSR).

Initiatives that can be undertaken by teachers with good digital leadership skills include building strategic partnerships with non-governmental organizations (NGOs), private or governmental. Joint sessions with the university can also be held. As Abdul Musid et al., (2023) suggests, the involvement of government, universities, industry, and industry is important for digital leadership in schools. Of course, the use of social media can help increase the success of this collaboration. In addition, participation in competitions or activities at the national and international levels increases opportunities to improve teachers' digital leadership. Having a professional learning community (PLC) also helps teacher colleagues. Conducting any form of online professional development is easy for everyone involved. Table 10 shows the threshold value, expert consensus percentage, defuzzification, and expert agreement decision on empowered professional.

Table 10: Findings of Threshold Values, Expert Consensus Percentage, Defuzzification, Expert Agreement Decision and Final Decision on Empowered Professional

Item	Triangular Fuzzy Number Requirements			Fuzzy Evaluation	Expert	Final
	Threshold	Average of Expert	Average of	Defuzzification	Agreement	Decision

	Value (d)	Threshold Value (d)	Consensus Percentage (%)	Expert Consensus Percentage (%)	(A_{max})	Decision	
1	0.163	0.200	77	58	0.859	Accept	Reject
1a	0.237		38		0.808	Reject	
2	0.116	0.184	85	85	0.910	Accept	Reject
2a	0.251		85		0.844	Reject	
3	0.217	0.171	85	89	0.867	Reject	Accept
3a	0.124		92		0.900	Accept	
4	0.183	-	85	-	0.879	Accept	Accept
4a	0.157		92		0.885	Accept	
5	0.091	-	92	-	0.923	Accept	Accept
5a	0.123		92		0.892	Accept	
6	0.148	-	85	-	0.895	Accept	Accept
6a	0.148		85		0.887	Accept	
7	0.238	-	77	-	0.844	Reject	Reject
7a	0.263		31		0.813	Reject	
8	0.148	-	85	-	0.887	Accept	Accept
8a	0.146		85		0.879	Accept	
9	0.218	-	85	-	0.864	Reject	Reject
9a	0.388		0		0.749	Reject	
10	0.237	-	77	-	0.846	Reject	Reject
10a	0.331		38		0.787	Reject	

Notes: the (-) represents both accepted situations and possible actions in a pair of items as they meet three conditions of FDM or rejected due to not complying with three conditions of FDM.

After examining the results of the FDM analysis for the construct of empowered professional, five item 3, 4, 5, 6, and 8 were accepted. However, only situations and sets of actions 4, 5, 6, and 8 meet the three FDM requirements, namely (i) threshold value (d) ≤ 0.2, (ii) expert group agreement ≥ 75 percent, and (iii) fuzzy score (A_{max}) ≥ 0.5. Therefore, one item is needed as the fifth item.

Item 7 and 9 should not be selected because the situation and set of action do not meet all the requirements of the FDM. Item 1, 2, and 3, on the other hand, can be considered because one of the situations or set of action meets the three FDM requirements. The selection method is to consider the average threshold value (d) ≤ 0.2 and the average expert agreement for the situation and set of action ≥ 75 percent. Item 3 is accepted because the average threshold value (d) of the situation and the set of action is 0.171 and the average agreement of the experts for the situation and the set of action is 89 percent.

According to International Society for Technology in Education (2017), the roles of educators in this construct are those of students, leaders, and citizens. As students, educators set professional learning goals to explore and apply pedagogical approaches using technology. As leaders, educators model for their colleagues the recognition, investigation, evaluation, development, and use of new digital resources and tools for learning. The educator's role as a citizen is to advise students on safe practices, adherence to laws and ethics when using digital devices, and protection of property and intellectual rights.

There are several situations related to this construct. Examples include testing the effectiveness of digital technology and how to help themselves and other teachers gain skills and access to digital technology so they can keep up with technological developments. The step teachers can take according to this construct is to offer appropriate courses, such as online professional development programs. Even better is to obtain a certification credential such as Microsoft Innovative Educator Expert, Apple Teacher, or Google Certified Educator. PLC implementation can also be done among teacher colleagues, e.g., through joint sessions and learning walks.

This can educate students about their digital rights and create a learning culture that is fostered by digital technologies in addition to improving students' digital literacy. Therefore, teachers can educate students not only about rules and ethics, but also about activities that are done with digital technology. Teachers can increase the use of applications in the teaching and learning process. communicate information to build strong relationships and promote learning. Table 11 shows the threshold value, expert consensus percentage, defuzzification, and expert agreement decision on learning catalyst.

Table 11: Findings of Threshold Values, Expert Consensus Percentage, Defuzzification, Expert Agreement Decision and Final Decision on Learning Catalyst

Item	Triangular Fuzzy Number Requirements		Fuzzy Evaluation	Expert Agreement Decision	Final Decision
	Threshold Value (d)	Expert Consensus Percentage (%)	Defuzzification (A_{max})		
1	0.157	92	0.892	Accept	Reject
1a	0.288	23	0.828	Reject	
2	0.288	23	0.828	Reject	Reject
2a	0.399	31	0.756	Reject	
3	0.153	92	0.900	Accept	Accept
3a	0.153	92	0.900	Accept	
4	0.313	23	0.821	Reject	Reject
4a	0.452	0	0.674	Reject	
5	0.153	92	0.900	Accept	Accept
5a	0.182	85	0.872	Accept	
6	0.183	85	0.879	Accept	Reject
6a	0.201	77	0.851	Reject	
7	0.148	85	0.887	Accept	Accept
7a	0.148	85	0.887	Accept	
8	0.148	85	0.887	Accept	Accept
8a	0.148	85	0.895	Accept	
9	0.148	85	0.887	Accept	Accept
9a	0.146	85	0.879	Accept	
10	0.148	85	0.895	Accept	Reject
10a	0.343	23	0.779	Reject	

The items selected for the construct of branding are item 3 and 3a, item 5 and 5a, item 7 and 7a, item 8 and 8a, and item 9 and 9a. All five situations and possible responses meet three conditions of the FDM: (i) the threshold value is ≤ 0.2, (ii) the expert group consensus value ≥ 75 percent, and (iii) the fuzzy score value (A_{max}) ≥ 0.5.

According to International Society for Technology in Education (2017), the role of the teacher within this construct is that of collaborator, designer, facilitator, and analyst. As collaborators, teachers will work and learn with students to explore and use new digital resources and diagnose and solve technical problems. Also, as designers, teachers will use technology to create, customize, and personalize learning experiences that promote free learning and adapt to student differences and needs. Teachers serving as facilitators will manage the use of technology and student learning strategies in digital platforms, virtual environments, and hands-on activities in their respective fields. Finally, as an analyst, the teacher will use technology for students and conduct various summative and formative assessments to meet students' needs, provide timely feedback, and guide them.

Some situations that are considered relevant to this construct are the lack of student response during the teaching and learning process and ways to engage student interest, as well as Internet disruptions that interfere with the smooth flow of the teaching and learning process. There are several ways to solve the dilemmas, such as using digital tools in the teaching and learning process. In addition, school administrators have a role to play by responding to teachers' complaints.

In addition, teachers need to provide, for example, the current format of examination papers and inform parents about the school. Possible measures include conducting an online program and using social media. Teachers also need to improve their knowledge of digital technology by obtaining a certificate of recognition. Another situation is finding a way or platform to store a large number of materials and information. To solve this dilemma, teachers can store in the cloud.

CONCLUSION

Finally, this article discusses the FDM results for nine constructs of digital leadership in teachers. For each construct, there are 10 item pairs at the first level. Each item pair consists of a situation and possible actions. In this study, the top five item pairs for each construct are selected. Three conditions must be met to be considered the best five-item pairs for each construct. The relevant conditions are that each situation and possible action must (i) meet the threshold (d) ≤ 0.2, (ii) the percentage of expert consensus $\geq$ is 75 percent,

and (iii) the fuzzy score (A_{max}) $\geq$ 0.5. However, there are several item pairs in which one of the situations or possible actions does not meet all the above conditions. Therefore, this study uses the mean threshold value (d) for both situations and possible actions and the mean percentage of expert agreement for both situations and possible actions. This study provides new insights into measurement because the FDM analysis is conducted in pairs rather than individually as is common in FDM analysis. It is suggested that future studies investigate the face validity of the best five item pairs selected for each construct.

LIMITATION

It is important to note that this study only focuses on nine constructs adopted from Sheninger (2019) and International Society for Technology in Education (2017). The nine constructs are (1) Student Engagement, Learning, and Outcomes; (2) Learning Environment and Spaces; (3) Professional Growth and Learning; (4) Communication; (5) Public relations; (6) Branding; (7) Opportunities; (8) Empowered Professionals; and (9) Learning Catalyst. In this study, Sheninger (2019) and International Society for Technology in Education (2017) are referenced because these two references are often used to reference digital leadership in the education system in the United States. In addition, the construct presented by Sheninger (2019) focuses on digital leadership of school leaders and is consistent with this study. The construct presented by International Society for Technology in Education (2017) also discusses the role of teachers in digital leadership. Therefore, the results of this study can contribute to the relevant construct in the context of digital leadership in Malaysia. The questionnaire uses a seven-point Likert scale based on appropriateness. A seven-point Likert scale is used because it can reduce ambiguity for each value of expert acceptance and agreement (Chang et al., 2011). The appropriateness-based scale was chosen because this study asked the panel to judge whether the relevant items were appropriate for the proposed construct of digital leadership.

Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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