

AWARENESS OF PEDAGOGICAL CONTENT KNOWLEDGE AMONG PRIMARY SCHOOL MATHEMATICS TEACHERS

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ABSTRACT: The study evaluated the awareness of Pedagogical Content Knowledge (PCK) among the primary school mathematics teachers of the Imphal district of Manipur. Further, the effects of demographic variables - gender, qualification, and school proprietorship on the teachers' PCK awareness were investigated. A random sample of 100 teachers which was ultimately reduced to 69 after post processing of collected data was used as the representative of the whole population of primary school mathematics teachers. The tool for data collection has 27 items covering 5 problems of geometry and measurement. Analysis done using descriptive and independent t-test statistics revealed that the awareness of Pedagogical Content Knowledge among the primary school mathematics teachers is moderate. It was also found that demographic variables of gender, qualification, and school proprietorship have significant impact on the teachers' PCK awareness.

KEYWORDS: Attitude; Secondary school; Teaching profession, Education

INTRODUCTION:

The National Curriculum Frameworks for School Education (2005) and Teacher Education (2009) emphasize a pedagogical and curricular approach that places significant responsibility on teachers. The frameworks identify three main curricular areas: (A) Foundations of Education, covering Learner Studies, Contemporary Studies, and Educational Studies; (B) Curriculum and Pedagogy, including Curriculum Studies and Pedagogic Studies; and (C) School Internship, aimed at fostering a broad range of perspectives, professional capabilities, and teacher sensitivities (NCFTE 2009, p. 24).

Pedagogical content knowledge (PCK) enables teachers to adapt concepts to students' abilities and interests, influencing how well students grasp subject matter (Chien L S, et. al., 2015). Effective teaching, integrating both cognitive and emotional aspects, enhances learning outcomes. Teacher competencies encompass Content Knowledge, PCK, Curriculum Knowledge, Pedagogical Skills, Understanding of Learners, Educational Contexts, and Educational Goals (Lee S, 1987), with PCK being especially pivotal, reflecting teachers' expertise in integrating pedagogical and content knowledge. According to (Romelia V M, et. al., 2003 and Baumert J, et.al., 2017) PCK would be able to anticipate misconceptions emerged in students to enhance students' learning outcomes. Manizade (2011) develop an assessment of teachers' PCK in geometry and measurement at the middle school level. In his assessment, various factors relating to PCK used in the research literature are mapped to five significant components of PCK. The components are as follows:

- Component 1. Knowledge of subject specific difficulties and misconceptions,
- Component 2. Knowledge of useful representations of the content,
- Component 3. Knowledge of developmental levels,
- Component 4. Knowledge of connections among “big math ideas,” and Component
- 5. Understanding of appropriateness of student’s proof, justifications, or
or mathematical discourse

Research Question

1. What are the levels of awareness of pedagogical content knowledge of primary school mathematics teachers in Imphal city of Manipur? How does it differ among the teachers?

Significance of the Study

This study is crucial for Manipur's education system, especially in mathematics, which currently lags the national average. It aims to determine whether mathematics teachers prioritize a student-centred approach over traditional methods. The findings will guide improvements in in-service training, subject knowledge updates, pedagogical skills, and professional development strategies. Given ongoing changes in teacher education, there's a critical need to renew and enhance competencies through updated training programs that sustain and build upon teachers' existing skills acquired during pre-service education.

Research Objectives

1. To study the awareness of pedagogical content knowledge of primary school mathematics teachers of Imphal city.
2. To study the awareness of primary school mathematics teachers of Imphal city on pedagogical content knowledge in relation to gender, academic qualifications and school proprietorship.

Research Hypotheses

H₀₁: Primary school mathematics teachers in Imphal city show a moderate level of awareness of Pedagogical Content knowledge overall.

H₀₂: Among primary school mathematics teachers in Imphal city, awareness of Pedagogical Content knowledge is significantly moderate across subgroups based on gender, academic qualification, and school proprietorship.

H₀₃: There is no significant difference in the mean scores of Pedagogical Content knowledge awareness between male and female teachers, teachers from government, private, and government-aided schools, or between trained and untrained teachers.

LITERATURE REVIEW:

Various studies have assessed Pedagogical Content Knowledge (PCK) among mathematics teachers, spanning both pre-service and in-service educators across different grade levels. Researchers like Morrison and Luttenegger (2015) focused on kindergarten teachers, while Lim and Guerra (2015) studied pre-service primary teachers. Şahin et al. (2016) examined prospective secondary teachers, and Danisman and Tanisli (2017) along with Özdemir and Soylu (2017) assessed in-service secondary teachers' PCK.

These studies employed diverse methods, including qualitative approaches (e.g., Turnuklu & Yesildere, 2007), quantitative methods (e.g., Lim & Guerra, 2015), and mixed methods (e.g., Martinovic & Manizade, 2017), aiming to comprehensively understand mathematics teachers' PCK.

RESEARCH DESIGN:

Method

The research employed a survey model and followed a quantitative research design. The primary goal of the selected research method is to seek answers to the validity of the research question through a field survey.

Sampling

The district-wise break-up of the initial sample of 100 teachers selected from the study area is given in Table 1.

Table 1: District Break-up of Initial Sample

Sl. No.	District	Gender		Proprietorship			Qualification		Total
		Male	Female	Govt.	Aided	Private	Trained	Untrained	
1.	Imphal West	34	20	21	12	21	28	26	54
2.	Imphal East	24	22	16	12	18	25	21	46

Data Collection Tool

Manizade (2006) created a PCK assessment tool focusing on geometry and measurement. This tool was adapted for primary school mathematics syllabi from the Board of Secondary Education, Manipur (BOSEM) and the Central Board of Secondary Education (CBSE), New Delhi. The study used Manizade's original specifications to select teacher assessment questions for a questionnaire used in data collection. Table 2 maps Manizade's original items to the researcher's questionnaire based on five components of PCK.

Table 2: Specification of Original Items From Manizade's Tool For Inclusion To The Researcher's Questionnaire

PCK component	Item No				
	2	3	8	9	10
	ABCD	ABCD	ABCD	1 2 3	A B
Component 1	Y	Y	Y	Y	
Component 2		Y	Y	Y	Y
Component 3		Y			Y Y
Component 4	Y	Y	Y	Y	
Component 5	Y	Y			

The original tool consisted of descriptive questions with correct answers defined by Manizade's scale. These questions were then transformed into closed-ended format, where

respondents select answers from a provided list of correct options. Respondents were instructed to choose "NONE OF THE ABOVE" if they couldn't answer a question, indicating a clear mathematical misunderstanding or lack of response. This resulted in a scale of 17 items across 5 mathematical problems

Data Collection Procedure

After obtaining permission from school heads, participating teachers were briefed on how to record their responses using the survey tool. Completed questionnaires were reviewed for errors and omissions. Incomplete or erroneous questionnaires were excluded, resulting in a final sample size reduction from 100 to 69 teachers. The distribution of the final sample across districts is detailed in Table 3.

Table 3: District Wise Break-up of Final Sample

Sl. No.	District	Gender		Proprietorship			Qualification		Total
		Male	Female	Govt.	Aided	Private	Trained	Untrained	
1.	Imphal West	24	12	12	5	19	20	16	36
2.	Imphal East	22	11	12	7	14	12	21	33

Scoring

The 17 items were rated on a scale from 1 to 3. A rating of 1 meant that the teacher selected the "NONE OF THE ABOVE" option of each item, indicating no answer due to an obvious mathematical misconception. A rating of 2 meant that less than 50% of the correct answers were selected for each item, indicating less than half of the questions were answered correctly. A rating of 3 meant that more than 50% of the correct answers were selected, indicating all or more than half of the questions were answered correctly.

RESULTS:

Level of awareness of Pedagogical Content knowledge

Descriptive statistics for the whole sample (N=69) of Primary School mathematics teachers of Imphal city are presented in Table 4.

The Mean, Median, and Mode of Pedagogical Content Knowledge are 26.86, 26, and 24, respectively, indicating central tendencies clustered around 27. This suggests a significantly moderate level of awareness of Pedagogical Content Knowledge, as shown in Figure 1's bar graph.

TABLE 4: Descriptive Statistics of the Distribution of Pedagogical Content Knowledge Awareness for the Whole Sample of Primary School Mathematics Teachers (N= 69)

Sl. No	PCK Component	Descriptive Statistical Constants								
		Min	Max	Mean	Median	Mode	Standard Deviation	Skewness	Kurtosis	Std. Error of Mean
1	Knowledge of subject specific difficulties and common misconception	4	9	6.3	6	6	1.08	0.28	0.11	0.13
2	Knowledge of useful representations of the content	4	8	5.83	6	6	0.74	-0.23	0.1	0.09
3	Knowledge of developmental levels	3	6	4.54	5	5	0.83	-0.55	-0.46	0.1
4	Knowledge of connections among “big math ideas”	5	8	6.64	7	6	1.05	0.61	-1.22	0.13
5	Understanding of appropriateness of student’s proof, justification or mathematical discourse	2	6	3.55	3	3	0.88	0.63	-0.13	0.11
Total		22	35	26.86	26	24	3.23	0.89	-0.49	0.39

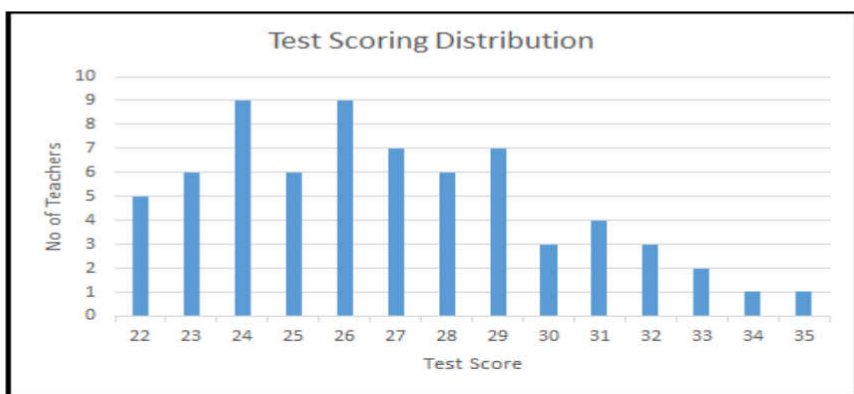


FIGURE 1: Bar Graph showing scoring pattern of Teachers in Test of Pedagogical Content Knowledge Awareness for the Whole Sample of Primary School Mathematics Teachers (N= 69)

TABLE 5: Frequencies and percentages of Low Aware, Moderate Aware, and High Aware Groups of Primary School Mathematics Teachers based on their test score of Pedagogical Content Knowledge Awareness for the whole Sample (N=69) and sub samples

Sl. No.	Criterion	Sample Total	Total	Awareness Score group					
				Low Level		Moderate Level		High Level	
				Total	P.C.(%)	Total	P.C.(%)	Total	P.C.(%)
1	Gender	Male	46	11	23.91	26	56.52	9	19.57
		Female	23	9	39.13	12	52.17	2	8.7
2	Proprietorship	Govt. School Teachers	24	8	33.33	13	54.17	3	12.5
		Aided School Teachers	12	5	41.67	7	58.33	0	0
		Private School Teachers	33	7	21.21	18	54.55	8	24.24
3	Qualification	Trained Teachers	32	0	0	21	65.63	11	34.38
		Untrained Teachers	37	19	51.35	18	48.65	0	0
Total			69	20	28.99	38	55.07	11	15.94

Further, Table 5 shows the distribution of teachers across awareness groups: 28.99% in the Low Aware Group (scores < M-σ), 55.07% in the Moderate Aware Group (M+σ ≤ scores ≤ M+σ), and 15.94% in the High Aware Group (scores > M+σ). These findings support the conclusion that the level of Pedagogical Content Knowledge Awareness among Primary School Mathematics Teachers in Imphal city is significantly moderate, confirming the research hypothesis.

Level of Awareness of Pedagogical Content knowledge in the sub-samples

Table 5 also indicates that, across all subsamples except those based on the Qualification variable, most teachers are in the ‘Moderate Aware Group’. However, among untrained teachers, only 48.65% are in the ‘Moderate Aware Group’, with 51.35% falling into the ‘Low Aware Group’. Therefore, research hypothesis Ho2 is supported in subsamples categorized by Gender and School Proprietorship, but not in the subsample of untrained teachers. These trends are depicted in Figure 2.

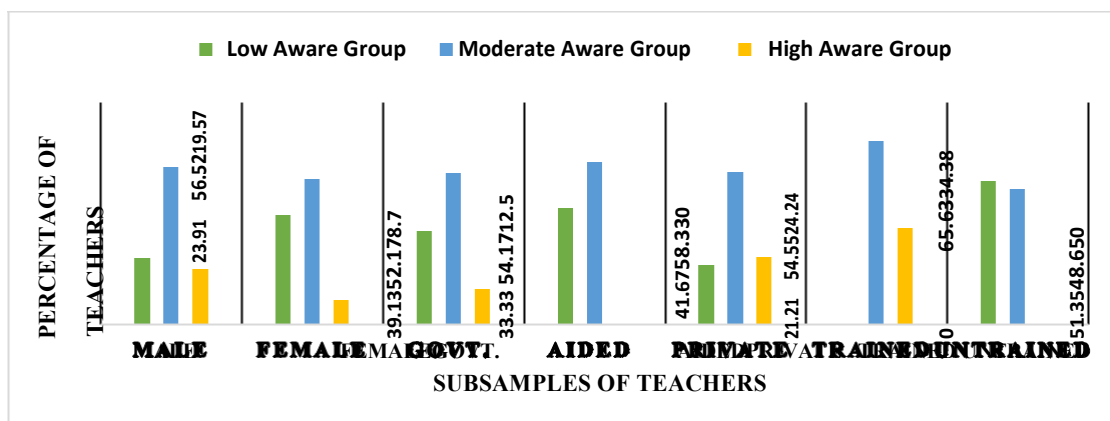


FIGURE 2: Graphical representation of Distribution of Teachers among the subsamples formed by Gender, Qualification, and School Proprietorship.

Differences in Awareness of PCK concerning demographic variables

To test the hypothesis H₀₃, investigator proposed three sub hypotheses namely (H_{03a}), (H_{03b}) and (H_{03c}) and tested in the following subsections.

Sub hypothesis H_{03a}: There is no significant difference between mean scores of Pedagogical Content Knowledge Awareness of Primary School Mathematics of Male and Female Teachers in Imphal city.

Statistical details of the comparison by means of Two-tailed test are given in Table 6. Results in Table 6 reveals that the critical ratios of the two-tailed 't' test is greater than 1.96, the 't' value required for significance at the 0.05 level for the whole population.

TABLE 6: Comparison of Mean Scores of Pedagogical Content Knowledge Awareness between Male and Female Teachers (Total Sample = 69)

Test Items of each PCK Component	Male		Female		't' Score
	Mean	Std. Deviation	Mean	Std. Deviation	
	Item 1-b	1.80	0.62	1.43	
Item 2-b	1.61	0.49	1.52	0.51	0.67
Item 3-c	1.54	0.59	1.52	0.59	0.14
Item 4-b	1.50	0.59	1.52	0.73	0.12
Total	6.46	1.00	6.00	1.21	1.56
Item 1-d	1.61	0.49	1.35	0.49	2.09
Item 2-d	1.46	0.50	1.48	0.51	0.17
Item 3-d	1.43	0.50	1.26	0.45	1.46
Item 4-c	1.41	0.54	1.57	0.51	1.15
Total	5.91	0.69	5.65	0.83	1.30
Item 2-b	1.61	0.49	1.52	0.51	0.67
Item 5-a	1.37	0.50	1.57	0.59	1.34
Item 5-b	1.50	0.59	1.57	0.59	0.42
Total	4.48	0.89	4.65	0.78	0.85
Item 1-a	1.54	0.55	1.26	0.54	2.04
Item 2-a	1.43	0.54	1.30	0.47	1.03
Item 3-a	1.20	0.40	1.26	0.45	0.59
Item 3-b	1.35	0.48	1.09	0.29	2.80
Item 4-a	1.41	0.50	1.13	0.34	2.75
Total	6.93	0.95	6.04	1.02	3.49
Item 1-c	2.15	0.73	2.26	0.62	0.65
Item 2-c	2.11	0.71	1.83	0.65	1.65
Total	3.65	0.95	3.35	0.71	1.49
PCK Awareness	27.43	3.18	25.70	3.14	2.16

The sub-hypothesis (H_{03a}) stating no significant difference in mean scores of Pedagogical Content Knowledge Awareness between Male and Female Teachers in Imphal city is rejected. Consequently, the research hypothesis that mean scores do not differ significantly between Male and Female Teachers is also rejected.

Additionally, the results reveal significant gender differences in mean scores across five out of seventeen test items and in one of the five PCK components. These findings are visually represented in Figure 3 below.

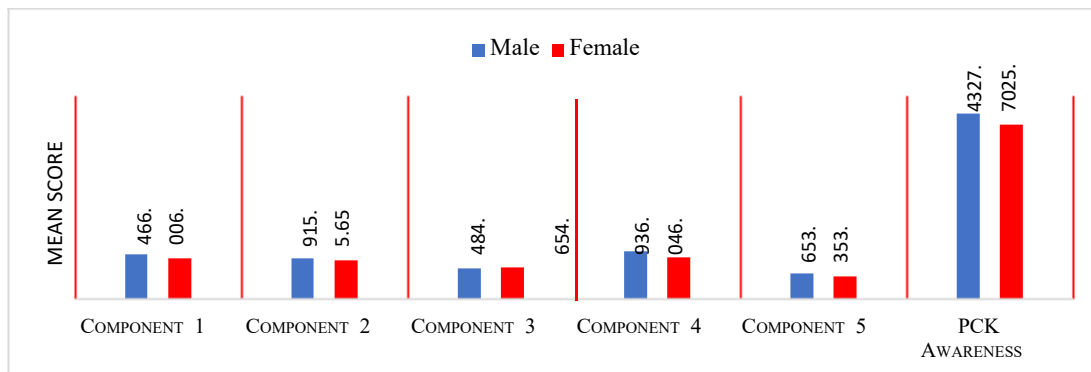


FIGURE 3: Graphical display of differences in mean scores of Male and Female Teachers in their Pedagogical Content Knowledge Awareness

Sub hypothesis H03b: There is no significant difference between mean scores of Pedagogical Content Knowledge Awareness of Primary School Mathematics of Trained and Untrained Teachers in Imphal city.

Table 7 shows significant differences in mean scores between Trained and Untrained Teachers across eleven out of seventeen test items and all five PCK components, as indicated by critical ratios of the two-tailed ‘t’ test exceeding 1.96, the threshold for significance at the 0.05 level. This suggests distinct levels of awareness between trained and untrained teachers on these items and PCK components.

Additionally, the critical ratio for the two-tailed ‘t’ test also exceeds 1.96 for overall PCK awareness. Therefore, sub-hypothesis (H03b) is rejected, leading to the rejection of the research hypothesis that mean scores of Pedagogical Content Knowledge Awareness do not significantly differ among Trained and Untrained Teachers.

These differences across all PCK components and the combined PCK score are depicted in Figure 4

FIGURE 4: Graphical display of differences in mean scores of Trained and Untrained Teachers in their Pedagogical Content Knowledge Awareness

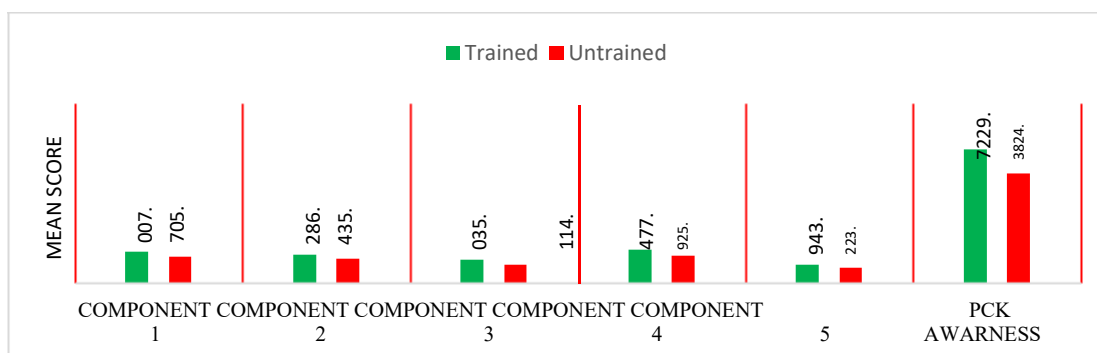


TABLE 7: Comparison of Mean Scores of Pedagogical Content Knowledge Awareness between Trained and Untrained Teachers (Total Sample = 69)

Test Items of each PCK Component	Teacher's Qualification				't' Score
	Trained Teachers		Untrained Teachers		
	Mean	Std. Deviation	Mean	Std. Deviation	
Item 1-b	1.97	0.69	1.43	0.5	3.62
Item 2-b	1.72	0.46	1.46	0.51	2.24
Item 3-c	1.72	0.63	1.38	0.49	2.46
Item 4-b	1.59	0.67	1.43	0.46	1.05
Total	7.00	1.05	5.70	0.7	5.95
Item 1-d	1.75	0.44	1.32	0.47	3.86
Item 2-d	1.66	0.48	1.30	0.46	3.14
Item 3-d	1.41	0.5	1.35	0.48	0.46
Item 4-c	1.47	0.57	1.46	0.54	0.07
Total	6.28	0.68	5.43	0.55	5.61
Item 2-b	1.72	0.46	1.46	0.51	2.24
Item 5-a	1.59	0.61	1.30	0.46	2.23
Item 5-b	1.72	0.68	1.35	0.7	2.45
Total	5.03	0.69	4.11	0.7	5.49
Item 1-a	1.78	0.55	1.16	0.37	5.36
Item 2-a	1.50	0.57	1.30	0.46	1.61
Item 3-a	1.31	0.47	1.14	0.35	1.76
Item 3-b	1.41	0.5	1.14	0.35	2.58
Item 4-a	1.47	0.51	1.19	0.4	2.52
Total	7.47	0.76	5.92	0.68	8.85
Item 1-c	2.31	0.64	2.08	0.72	1.41
Item 2-c	2.22	0.71	1.84	0.65	2.32
Total	3.94	0.88	3.22	0.75	3.64
PCK Awareness	29.72	2.19	24.38	1.5	11.65

Sub hypothesis H03c: There is no significant difference between mean scores of Pedagogical Content Knowledge Awareness of Primary School Mathematics Teachers in Imphal city with respect to School Proprietorship.

To test this sub hypothesis one way analysis of variance (ANOVA) is performed for testing of significant difference in the mean scores of teachers falling the subgroups formed by School Proprietorship. The results obtained are shown in Table 8.

TABLE 8: Results of Analysis of Variance for the Pedagogical Content Knowledge Awareness of Primary School Mathematics Teacher with respect to School Proprietorship

PCK Component	Test Item of each PCK Component	Between Group		Within Group		'F' Score
		SSE	MSE	SSE	MSE	
Component 1	Item 1-b	2.87	1.43	26.12	0.40	3.62
	Item 2-b	0.13	0.06	16.68	0.25	0.26
	Item 3-c	0.02	0.01	23.14	0.35	0.03
	Item 4-b	0.50	0.25	26.74	0.41	0.62
	Component 1 Total	4.46	2.23	76.14	1.15	1.93
Component 2	Item 1-d	0.83	0.42	16.39	0.25	1.67
	Item 2-d	0.64	0.32	16.52	0.25	1.29
	Item 3-d	0.07	0.03	16.14	0.24	0.14
	Item 4-c	0.85	0.42	18.31	0.28	1.53
	Component 2 Total	5.73	2.87	32.18	0.49	5.88
Component 3	Item 2-b	0.13	0.06	16.68	0.25	0.26
	Item 5-a	0.21	0.11	20.74	0.31	0.34
	Item 5-b	0.96	0.48	26.26	0.40	1.20
	Component 3 Total	1.20	0.60	45.96	0.70	0.86
Component 4	Item 1-a	0.68	0.34	20.39	0.31	1.10
	Item 2-a	0.25	0.13	18.18	0.28	0.46
	Item 3-a	0.72	0.36	11.02	0.17	2.16
	Item 3-b	0.13	0.07	13.17	0.20	0.34
	Item 4-a	0.15	0.07	14.84	0.22	0.33
	Component 4 Total	4.72	2.36	71.22	1.08	2.19
Component 5	Item 1-c	6.96	3.48	25.59	0.39	8.97
	Item 2-c	3.34	1.67	29.64	0.45	3.72
	Component 5 Total	3.68	1.84	49.39	0.75	2.46
	Total PCK Awareness	57.33	28.67	661.22	10.02	2.86

Table 8 shows that the calculated F-value for Total Pedagogical Content Knowledge Awareness is 2.86, which is less than the table value (3.00) at the 0.05 level of significance for (2, 66) degrees of freedom. Therefore, sub-hypothesis H_{03c} , stating no significant difference in mean scores of Pedagogical Content Knowledge Awareness among Primary School Mathematics Teachers in Imphal city with respect to School Proprietorship, is accepted. Consequently, the research hypothesis that mean scores do not significantly differ among teachers working in Government, Private, and Government-Aided Schools is also accepted.

Notably, differences in mean scores are observed specifically in test items Item 1-b, Item 1-c, and Item 2-c among teachers in Government, Private, and Government-Aided Schools. Similarly, there are significant variations in mean scores among these groups in the second component of PCK, Knowledge of useful representations of content.

CONCLUSION:

Our study delved into a significant area of research, namely Pedagogical Content Knowledge. Findings revealed that only 15.94% of primary school mathematics teachers exhibited a high level of PCK awareness, while 55.07% fell within the moderate awareness bracket. Moreover, the study revealed that there is a statistically significant difference in the awareness level of PCK between male and female, and trained and untrained mathematics

teachers. Conversely, no statistically significant difference in PCK among teachers working in Government, Private, and Government Aided Schools is discovered.

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