



Pedagogical Content Knowledge of Prospective Mathematics Teachers: A Gender-Based Analysis

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Abstract: Pedagogical content knowledge (PCK) is an important component of teacher knowledge because it concerns the ways in which subject matter is understood and transformed for teaching and learning. The present study examined the pedagogical content knowledge of prospective mathematics teachers and specifically investigated whether their PCK differed by gender. A survey method was adopted, and 566 prospective mathematics teachers from Thoothukudi, Tirunelveli, Tenkasi and Kanyakumari districts of Tamil Nadu were selected through simple random sampling. Data were collected using an adapted Pedagogical Content Knowledge Scale developed by Michael J. Leo and Annaraja. The instrument covered nine dimensions: philosophy and sociology, classroom management, curriculum and instruction, methodology, techniques, technology, psychology, evaluation, and content knowledge. Descriptive statistics were used to determine the levels of PCK, and an independent-samples t test was used to examine gender differences. The findings indicated that most prospective mathematics teachers demonstrated moderate levels of PCK across the dimensions. No statistically significant gender difference was found in philosophy and sociology, classroom management, curriculum and instruction, methodology, technology, psychology, evaluation, or overall PCK. However, statistically significant gender differences were reported in techniques and content knowledge, with female prospective mathematics teachers obtaining higher mean scores than male prospective mathematics teachers. The findings highlight the need for mathematics teacher-education programmes to provide systematic opportunities for developing both subject-specific knowledge and pedagogical techniques.

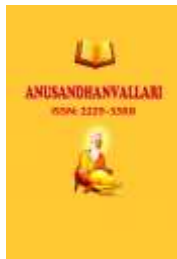
Keywords: Pedagogical Content Knowledge; Prospective Mathematics Teachers; Mathematics Teacher Education; Content Knowledge; Teaching Techniques; Gender

Introduction

The quality of mathematics teaching depends not only on teachers' knowledge of mathematical content but also on their ability to transform that knowledge into forms that learners can understand. Shulman introduced pedagogical content knowledge (PCK) as part of the knowledge base for teaching and drew attention to the relationship between subject matter knowledge and pedagogical reasoning. PCK concerns the transformation and representation of subject matter for particular learners and teaching situations [1], [2]. This perspective shifted attention from viewing effective teaching as a matter of either content knowledge or general pedagogy alone to considering the interaction between the two.

In mathematics education, Ball, Thames, and Phelps [3] distinguished forms of mathematical knowledge that are particularly relevant to teaching and argued that knowledge used in teaching cannot be reduced to the mathematical knowledge required by non-teachers. PCK therefore has particular significance in mathematics teacher education because prospective teachers need opportunities to connect mathematical ideas with representations, explanations, instructional strategies, assessment practices, and learners' ways of thinking.

PCK is also viewed as a knowledge base that develops through teacher education and professional experience. Loughran, Berry, and Mulhall [4] emphasised the importance of making teachers' pedagogical content knowledge visible and developing it through systematic reflection on teaching. Kultsum [5] highlighted its role



in supporting teaching quality and the selection of appropriate teaching strategies. These perspectives indicate that teacher-education programmes need to provide structured experiences through which prospective teachers can integrate what they know about mathematics with how mathematics can be taught to diverse learners.

In the present study, PCK is examined through the dimensions represented in the adapted Pedagogical Content Knowledge Scale. The dimensions include philosophy and sociology, classroom management, curriculum and instruction, methodology, techniques, technology, psychology, evaluation, and content knowledge. The study focuses specifically on prospective mathematics teachers because the transition from being a learner of mathematics to becoming a teacher of mathematics requires the development of knowledge that is oriented towards teaching rather than learning the subject alone.

Gender differences in teacher knowledge should be examined carefully rather than assumed. A statistically significant difference in a particular dimension does not by itself establish the reasons for that difference. The present study therefore focuses on describing the observed pattern and determining whether statistically significant gender differences exist in PCK and its dimensions.

Need And Significance Of The Study

Prospective teachers enter teacher-education programmes with different levels of subject knowledge, pedagogical understanding, prior learning experiences, and expectations about teaching. Mathematics teacher education therefore needs to support the integration of mathematical knowledge with the knowledge and skills required to explain, represent, sequence, assess, and adapt mathematical ideas for learners. PCK provides a useful perspective for examining this integration.

The significance of the present study lies in its focus on prospective mathematics teachers and on multiple dimensions of knowledge related to teaching mathematics. Identifying areas in which prospective teachers demonstrate relatively lower or higher levels of PCK can help teacher educators design appropriate learning experiences. In particular, the gender comparison may indicate whether similar or different patterns of development are observed among male and female prospective mathematics teachers in the selected context.

Objectives Of The Study

- To find out the level of pedagogical content knowledge of male and female prospective mathematics teachers.
- To find whether there exists a significant difference in the pedagogical content knowledge of prospective mathematics teachers with respect to gender.

Hypothesis Of The Study

H₀₁: There is no significant difference between male and female prospective mathematics teachers in pedagogical content knowledge and its dimensions.

Methodology

Research Design

Survey design was adopted to examine the pedagogical content knowledge of prospective mathematics teachers.

Sample And Sampling Technique

The sample consisted of 566 prospective mathematics teachers from Thoothukudi, Tirunelveli, Tenkasi, and Kanyakumari districts of Tamil Nadu. The sample comprised 44 male and 522 female prospective mathematics teachers. Simple random sampling technique was used for selecting the participants.

Tool Used

The investigator adapted Pedagogical Content Knowledge Scale developed by Michael J. Leo and Annaraja for collecting the data. The dimensions represented in the instrument were philosophy and sociology, classroom management, curriculum and instruction, methodology, techniques, technology, psychology, evaluation, and content knowledge.

Data Analysis

Descriptive statistics were used to classify the level of PCK among male and female prospective mathematics teachers. An independent-samples t test was used to examine whether the mean scores of male and female prospective mathematics teachers differed significantly in overall PCK and its dimensions. The statistical significance level was set at 0.05.

Objective 1: To find out the level of PCK of prospective Mathematics teachers with respect to their gender

Table 1 Level of PCK of prospective Mathematics teachers with respect to their gender

PCK and its Dimensions	Gender	Low		Moderate		High	
		N	%	N	%	N	%
Philosophy–Sociology	Male	18	40.9	25	56.8	1	2.3
	Female	238	45.6	283	54.2	1	0.2
Classroom Management	Male	10	22.7	24	54.5	10	22.7
	Female	80	15.3	305	58.4	137	26.2
Curriculum-Instruction	Male	12	27.3	16	36.4	16	36.4
	Female	98	18.8	240	46.0	184	35.2
Methodology	Male	18	40.9	6	13.6	20	45.5
	Female	143	27.4	138	26.4	241	46.2
Techniques	Male	25	56.8	13	29.5	6	13.6
	Female	199	38.1	261	50.0	62	11.9
Technology	Male	13	29.5	29	65.9	2	4.5
	Female	96	18.4	426	81.6	0	0.0
Psychology	Male	15	34.1	10	22.7	19	43.2
	Female	138	26.4	172	33.0	212	40.6
Evaluation	Male	16	36.4	26	59.1	2	4.5
	Female	140	26.8	382	73.2	0	0.0
Content Knowledge	Male	12	27.3	29	65.9	3	6.8
	Female	113	21.6	304	58.2	105	20.1
PCK in Total	Male	13	29.5	28	63.6	3	6.8
	Female	101	19.3%	350	67.0%	71	13.6

The table 1 provides data on PCK levels among male and female prospective Mathematics teachers. It shows that moderate PCK was the most common category for overall PCK among both groups. Among males, 2.3% exhibited a high level of knowledge in philosophy–sociology, 22.7% in classroom management, 36.4% in curriculum–instruction, 45.5% in methodology, 13.6% in techniques, 4.5% in technology, 43.2% in psychology, 4.5% in evaluation, and 6.8% in content. Overall, 6.8% of male prospective Mathematics teachers exhibited a high level of PCK.

Among females, 0.2% exhibited a high level of knowledge in philosophy–sociology, 26.2% in classroom management, 35.2% in Curriculum-Instruction, 46.2% in methodology, 11.9% in techniques. 0.0% in technology, 40.6% in psychology, 0.0% in evaluation, and 20.1% in content. In total, 13.6% of the female prospective Mathematics teachers demonstrated a high level of PCK.

Hypothesis 1

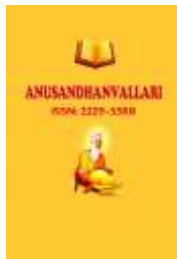
There is no significant difference between male and female prospective Mathematics teachers in their PCK and its dimensions

Table 2 Difference between male and female prospective Mathematics teachers in their PCK and its dimensions

PCK and its Dimensions	Male (N =44)		Female (N =522)		Calculated 't' value	Calculated 'p' value	Remarks
	Mean	S. D	Mean	S. D			
Philosophy-Sociology	1.39	0.920	1.38	0.745	0.023	0.982	NS
Classroom Management	2.59	1.168	2.75	1.087	0.932	0.351	NS
Curriculum-Instruction	3.36	1.727	3.58	1.490	0.923	0.356	NS
Methodology	7.18	2.781	7.45	2.566	0.657	0.511	NS
Techniques	2.27	1.676	2.80	1.404	2.016	0.049*	S
Technology	2.14	1.002	2.25	0.838	0.725	0.472	NS
Psychology	3.48	1.982	3.75	1.771	0.975	0.330	NS
Evaluation	3.70	1.972	3.81	1.819	0.381	0.703	NS
Content	9.73	4.652	11.34	5.069	2.035	0.042*	S
PCK in Total	35.66	14.106	39.11	12.767	1.709	0.088	NS

Note. S = Significant; NS = Not Significant. * $p < .05$. The exact * t^* and * p^* values shown above are based on the statistical table supplied by the researcher.

The results show no statistically significant gender difference in philosophy and sociology, classroom management, curriculum and instruction, methodology, technology, psychology, evaluation, or overall PCK. Significant differences were found only in techniques (* $t^* = 2.016$, * $p^* = .049$) and content knowledge (* $t^* =$



2.035, $*p* = .042$). In both dimensions, female prospective mathematics teachers obtained higher mean scores than male prospective mathematics teachers. For overall PCK, the female group had a higher mean score, but the difference was not statistically significant ($*t* = 1.709$, $*p* = .088$).

Discussion

The results show that moderate PCK was the most common level among both male and female prospective mathematics teachers. This indicates that most participants had a reasonably developed understanding of the knowledge required for teaching mathematics, although fewer participants were placed in the high-PCK category. This pattern is consistent with the view that PCK develops gradually as prospective teachers connect mathematical content with pedagogy, curriculum, learners, and classroom practice [1]–[4].

The comparison of overall PCK scores did not show a statistically significant gender difference. Although the female participants had a higher mean score (39.11) than the male participants (35.66), the difference was not statistically significant ($*t* = 1.709$, $*p* = .088$). A similar pattern was found in most individual dimensions. Thus, in the present sample, gender was not associated with a significant difference in overall PCK.

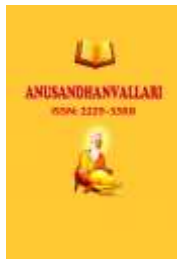
A statistically significant difference was found in the techniques dimension. Female prospective mathematics teachers obtained a higher mean score (2.80) than male prospective mathematics teachers (2.27), and the difference was significant at the 0.05 level ($*t* = 2.016$, $*p* = .049$). The present study was not designed to identify why this difference occurred. Possible explanations, such as differences in prior educational experiences or opportunities for practice, should therefore be investigated separately rather than inferred from the present findings.

A statistically significant difference was also found in content knowledge. Female prospective mathematics teachers obtained a higher mean score (11.34) than male prospective mathematics teachers (9.73), with the difference reaching statistical significance ($*t* = 2.035$, $*p* = .042$). Sound mathematical understanding is important for explaining concepts, selecting examples, responding to learners' questions, and addressing errors. The finding therefore highlights the importance of providing all prospective teachers with sufficient opportunities to strengthen their mathematical content knowledge.

Taken together, the findings show that the gender differences were confined to techniques and content knowledge; they did not extend to overall PCK. This is important because PCK is multidimensional, and a difference in one or two components does not necessarily translate into an overall difference in professional knowledge. Mathematics teacher-education programmes should therefore focus on developing the full range of PCK while remaining responsive to individual learning needs.

Educational Implications

- Teacher-education programmes should provide systematic opportunities for prospective mathematics teachers to connect mathematical content with appropriate teaching strategies and learner needs.
- Microteaching, lesson planning, demonstration lessons, peer teaching, and reflective activities can be used to strengthen prospective teachers' pedagogical techniques.
- Teacher educators should identify areas of relatively lower PCK through diagnostic assessment and provide targeted learning experiences.
- Mathematics teacher education should provide sustained opportunities for strengthening mathematical content knowledge alongside pedagogical knowledge.
- Learning opportunities should be equitable and supportive for all prospective teachers, while remaining responsive to individual differences in learning needs.



Delimitations Of The Study

- The study is delimited to prospective mathematics teachers from four districts of Tamil Nadu.
- The study is delimited to final year prospective teachers specializing in the Mathematics subject only. Prospective teachers from other subject specializations are not included.
- Pedagogical content knowledge has been measured in terms of philosophy-sociology, curriculum-instruction, methodology, techniques, communication, technology, psychology, evaluation, and content knowledge in mathematics.
- The data collected for the study is self-reported through standardized or structured tools, which may reflect the perceptions of the respondents at the time of data collection.

Conclusion

The present study examined the pedagogical content knowledge of 566 prospective mathematics teachers from four districts of Tamil Nadu. Moderate PCK was the predominant level among both male and female participants. The findings showed no statistically significant gender difference in overall PCK or in most of its dimensions. However, statistically significant gender differences were reported in techniques and content knowledge, with female prospective mathematics teachers obtaining higher mean scores in both dimensions. These findings suggest that mathematics teacher-education programmes should continue to strengthen both mathematical content knowledge and pedagogical techniques through structured, practice-oriented learning experiences. Future studies may investigate the factors associated with differences in particular PCK dimensions and may use larger and more balanced gender groups as well as multiple measures of PCK.

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