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Research Article

Pedagogical Content Knowledge Towards Technological Approach In Mathematics Classroom

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ABSTRACT

Knowledge of subject matter to be transferred to the learners is content knowledge, and the knowledge of how that content knowledge has to be transferred for making learners understand is pedagogical content knowledge (PCK). For making learners understand teachers have to take the help of some devices or to apply some strategies which have to generate based on the nature of contents by the concerned teachers and this is the most challenging task for making a highly effective classroom session. In today's high-tech environment, traditional chalk-board and lecture methods are obsolete in the landscape of teaching and learning. Technologically advanced tools have been playing a pivotal role in transforming entire education system. However, for effective application of content-fit technological tools teachers must be enriched in technological pedagogy.

The study intends to investigate the status on teachers' pedagogical content knowledge towards technological approach in mathematics classroom of secondary standard within the district of Kamrup Metro, Assam for which the researchers adopted a descriptive survey method for the study. One sample Kolmogorov-Smirnov and Shapiro-Wilk test is used for testing if the data follows normal distribution or not and the Mann Whitney U Test was applied to study the significant difference between two groups; moreover, to study the correlation between teachers' pedagogical content knowledge and academic achievement of students in mathematics, Spearman's correlation co-efficient was computed.

There is no significant difference between the teachers' pedagogical content knowledge towards use of technology in teaching mathematics in digital and traditional modes from the perception of students both from government and private sectors.

I. Introduction:

In today's high-tech environment traditional chalk-board and lecture methods are obsolete in the landscape of teaching and learning. Technologically advanced tools have been playing a pivotal role in transforming entire education system. Several studies like- Anderson, 2000; Yusuf, 2005; Basargekar & Singhavi, 2017; Iwu, 2006 etc revealed how significantly important these tools are, especially in aspects of students' motivation and teachers' teaching proficiency.

The term pedagogy is generated from Greek word 'Paidagogos' which implies "to teach". In UNESCO report, 2018, it was stated how teachers' pedagogical practices had an impact on students' learning. Pedagogically enriched teachers will be able to offer solutions to some of the teaching problems that impede teacher-student pedagogical experience, Misra (2008). "ICT compliance comprises not only the mastery of technical skills and procedures, but also the understanding of how to employ these talents judiciously and responsibly in facilitating pedagogical experiences", Oluwatayo (2012). During the period of 1960 and 1980 several studies on

teaching had been conducted for which pedagogy had grown in popularity in this period where, knowledge, judgement, beliefs and abilities had been connected to teaching methods, Grossman (1990). Cohen (1986) stated that pedagogy implied to the understanding of instructional principles in a small group as well as knowledge and abilities linked to classroom management, Doyle (1986).

1.1 Pedagogical Content Knowledge (PCK):

Knowledge of subject matter to be transferred to the learners is content knowledge, and the knowledge of how that content knowledge has to be transferred for making learners understand is pedagogical content knowledge (PCK). For making learners understand teachers have to take the help of some devices or to apply some strategies which have to generate based on the nature of contents by the concerned teachers. This is the most challenging task for making a highly effective classroom session. Integrating these two types of knowledge a new terminology PCK had been conceptualised for the first time in Shulman (1986).
Based on the description in Shulman's study a paradigm shift had been made as 'TPACK' in Mishra P & Koehler, M J (2006) where TPACK stands for- Technological Pedagogical and Content Knowledge. In today's high-tech environment pedagogical skill can be enhanced with the strategic use of technological tools. Therefore, it can be considered that the integration of Technological Knowledge (TK), Pedagogical Knowledge (PK) and Content Knowledge (CK) will enhance the quality of teaching to another dimension.

1.2 Technological Content Knowledge (TCK):

Technological content knowledge refers to the awareness that technology and content matter impact and restrain one another as stated in Mishra & Koehler, (2006). TCK covers teachers' ideas on how they construct ways with the contents and technology for effective learning. Clark (2013) stated TCK must be flexible, creative and adaptive to operate and deploy technology in context-specific manner.

1.3 Technological Pedagogical Knowledge (TPK):

Technological pedagogical knowledge refers to connections between technological tools and specific pedagogical practices. TPK outlines teachers' perceptions on how content-fit tools can be used for making the learners understand easily. Schmidt, Baran, Thompson, Mishra, Koehler, and Shin (2009), TPK is "knowledge of how various technologies might be used in teaching, as well as an understanding that employing technology may transform the way teachers teach"

1.4 Technological Pedagogical Content Knowledge (TPACK):

It refers to the knowledge about how to use technology in developing pedagogy for a particular content. TPACK is a strategy which integrates teachers' knowledge towards how they impart and how they use technology. Experiencing in separate component and in their intersection is different. TPACK is the intersection of technological knowledge, pedagogical knowledge and content knowledge. It highlights links between these components displaying how teachers' knowledge of technology, pedagogy and content interact to build an effective and systematic teaching with educational technology. "TPACK is a hypothesis which elaborates the bunch of knowledge that teachers need to properly teach their pupils and use technology" (Mc. Grow-Hill, 2019). In a study Archambault & Crippen (2009) it was rightly mentioned that gaining competency in TPACK is required for effective ICT integration. "In order to develop an effective foundation for teaching using educational technology, TPACK is the product of numerous combinations and interests in three major underlying domains of content, pedagogy, and technology" Das G C & Sarmah D (2020). As reported in Cox & Graham (2009), TPACK directly assists concerned teachers in comprehending the potential contributions of emerging technologies in education. Moreover, Graham (2011) opined that TPACK may be used to assess how teachers' professional growth influences their classroom sessions while use ICT.
In this study the researchers intend to investigate the status on teachers' pedagogical content knowledge towards technological approach in mathematics classroom of secondary standard within the district of Kamrup Metro, Assam.

2. Objectives:

- To investigate the teachers' pedagogical content knowledge towards the use of technology in mathematics classroom from the perception of students.
- To investigate how correlation between teachers' pedagogical content knowledge towards the use of technology and students' achievement in mathematics exists.

3. Methodology:

As this study is descriptive in nature, the researchers adopted a descriptive survey method for the study.

3.1 Research tools:

- Questionnaire: 5-point Likert scale rated from five possible responses: strongly agree-5, agree-4, neutral-3. Disagree-2 and strongly disagree-1, with score range from 20 to 100.
- Reliability: considering conservative estimate of reliability Cronbach's alpha co-efficient is found to be 0.81.

- Validity: validity can be measured from the index of reliability and which was found 0.90, as Index of reliability = √r, where r = reliability co-efficient (0.81).
- One sample Kolmogorov-Smirnov and Shapiro-Wilk test is used for testing if the data follows normal distribution or not.
- The Mann Whitney U Test was applied to study the significant difference between two groups.
- To study the correlation between teachers' pedagogical content knowledge and academic achievement of students in mathematics, Spearman's correlation co-efficient was computed.

3.2 Population:

Total population of secondary level students under the study area comprising both from government and private sectors is found as 26,239. There are two types of categories one SEBA (Secondary Education Board of Assam) and the other is CBSE (Central Board of Secondary Education).

3.3 Sample Size:

Using Yamane's formula with ± 5% precision and assuming 95% confidence and p=0.5 sample size is found 394 which is rounded as 400. Category wise samples were considered through proportion allocation method using Cochran formula.

Table-1: Category wise student samples from digital and traditional classrooms:

Sl No	Category of School	No. of students in digitally equipped classroom	Sample size	No. of students in Traditional Classroom	Sample size
1	SEBA (govt.)	3055	47	8325	127
2	SEBA (pvt.)	3655	56	4279	65
3	CBSE (pvt.)	5435	83	1476	22
	Total		186		214

Table-2: Category wise school samples from digital and traditional classrooms:

Category of School	No. of schools with digitally equipped classroom	Sample size	No. of schools with Traditional Classroom	Sample size
SEBA (govt.)	24	2	78	6
SEBA (pvt.)	29	2	38	3
CBSE (pvt.)	34	3	10	1
Total	87	7	126	10

Table-3: Category wise student samples from digital and traditional classrooms:

Category of School	No. of schools with digitally equipped classroom	Population	sample	No. of schools with traditional classroom	Population	sample
SEBA (govt.)	2	104	47	6	260	127
SEBA (pvt.)	2	179	56	3	134	65
CBSE (pvt.)	3	297	83	1	46	22
Total	7	580	186	10	440	214

4. Hypotheses:

The following null hypotheses are considered to test and decide whether data sufficiently support particular hypothesis or not.

H_{01}. There is no significant difference between the teachers' PCK towards teaching mathematics in digital and traditional classroom from the perception of students**.**

H_{02}. There is no significant difference between the teachers' PCK towards the use of technology in mathematics classroom from the perception of government and private school students.

H_{03}. There is no significant impact of teachers' PCK towards use of technology on academic achievement of government school students in mathematics.

H_{04}. There is no significant impact of teachers' PCK on the academic achievement of private school students in mathematics.

5. Analysis and discussion:

The researchers collected the data physically with due permission from the concerned authorities through strategically designed 5-point Likert scale questionnaire after reliability and validity tests. Data were systematically analysed through the software SPSS and observed accordingly how hypotheses were accepted or rejected.One sample Kolmogorov-Smirnov and Shapiro-Wilk normality test for teachers' Pedagogical content knowledge was run to make confirm whether the data were normally distributed or not.

Table-4: Normality Tests:

Test of Normality						
	Kolmogorov-Smirnov[a]			Spapiro-Wilk		
	Statistic	df	Sig.	statistic	df	Sig.
PCK	0.055	186	0.005	0.989	186	0.003
Lilliefors Significance Correction						

Table 4 indicates that the data related to teachers' pedagogical content knowledge were not normally distributed ($p < 0.05$) for which non-parametric analysis was run as it does not assume normality. The Mann-Whitney U Test was used to compare two different groups. Spearmen's rank co-relation co-efficient was used as a non-parametric alternative to Pearson's correlation to find the relationship between two variables.

5.1. Interpretation of H_{01}

Table-5: Mann-Whitney U Test for ranks comparing of PCK in both digital and traditional classrooms:

Ranks				
	Mode of classrooms	N	Mean Rank	Sum of Ranks
PCK	Digital	186	197.58	36768.30
	Traditional	214	202.85	43431.30

Table-6: Mann-Whitney U Test of significance:

Test Statistic[a]	
	PCK
Mann-Whitney U	19377.49
Wilcoxon W	36768.45
Z	-0.455
Asymp sig. (2tailed)	0.647
a. Grouping variables: Digital and Traditional classrooms	

Table-5 reveals that the mean rank and sum of ranks in traditional mode of teaching category higher than the digital mode of teaching category. Test Statistic table-6 decides that there is sufficient evidence to accept the null hypothesis i.e., there is no significant difference between the teachers' PCK towards the use technology in teaching mathematics in digital and traditional mode of teaching ($Z=-0.455$, $p=0.647$).

5.2 Interpretation of H_{02}:

Table-7: Mann-Whitney U Test for ranks comparing of PCK in both govt. and Pvt. schools:

Ranks				
	Category	N	Mean Rank	Sum of Ranks
PCK	Govt.	47	100.23	4712.45
	Pvt.	139	91.20	12678.55

Table-8: Mann-Whitney U Test of significance:

Test Statistic[a]	
	PCK
Mann-Whitney U	2948.44
Wilcoxon W	12678.50
Z	-0.998
Asymp sig. (2tailed)	0.317
a. Grouping variables: govt. and pvt. schools	

From the table-7 it is observed that the mean rank of govt. category is higher than in private category and the sum of ranks in private category is higher than the govt. category. Table-8 of test statistic indicates that there is sufficient evidence to accept the null hypothesis as p-value=0.317 and z-value =-0.998 i.e., there is no significant difference between the teachers' PCK towards the use of technology in mathematics classrooms of govt. and private schools.

5.3. Interpretation of hypothesis H_3:

Table-9: Regression model summery of mean scores of the variables PCK on academic achievement f govt. schools' students:

Model summery				
Model	R	R-square	Adjusted R-square	Standard error estimate
1	.119[a]	.014	.007	5.703
a. Predictors: Constant, PCK				

In the regression model summery for prediction of academic achievement of govt. school students from variable teachers' PCK the value of R (.119) gives a positive and low degree of correlation, furthermore the value of R-square was found to be .014, which depicts that the overall model explained 1.40% of the variance could be predicted from the teachers' PCK. For the test of significance let's look at the table 10.

Table-10: Regression ANOVA summery:

ANOVA[b]						
Model		Sum of squares	df	Mean square	F	Sig.
1	Regression	80.847	1	80.847	2.486	.117[a]
	Residual	5591.911	45	32.510		
	Total	5672.758	46			
a. Predictors: (constant), PCK						
b. Dependent variable: Academic achievement						

In the regression ANOVA summery for the prediction of academic achievement of govt. school students from the mean scores of teachers' PCK, it indicates that the model was not statistically significant F (1, 45) = 2.486, p>.05. Table-11 reflects the contribution of the variable.

Table-11: Regression ANOVA summery:

Coefficients[a]						
Model		Unstandardized coefficients		Standardized coefficients	t	Sig.
		B	Std. Error	Beta		
1	Constant	67.704	3.558		19.022	.000
	PCK	.077	.051	.119	1.576	.117
a. Dependent variable: academic achievement						

In this investigation of teachers' PCK's contribution to the prediction of the dependent variable, the independent variable teachers' PCK was found not to make statistically significant contribution (Beta=0119, t=1.576, p>.05) in explaining the academic achievement of students. Therefore, the null hypothesis of having on significant impact of teachers' PCK towards the use of technology on the academic achievement of govt. school students is accepted.

5.4. Interpretation of hypothesis H_4:

Table-12: Regression model summery of mean scores of the variables PCK on academic achievement of private schools' students:

Model summary				
Model	R	R-square	Adjusted R-square	Std. error of the estimate
1	.263[a]	.068	.066	5.817
a. Predictors:(constant), teachers PCK				

Table-12 indicates the regression model summary to predict academic achievement of private school students from the variable teachers' PCK, where the R value (.263) shows a positive and low degree of correlation; furthermore, R-square value was found to be (.068). Thus, overall model explained 6.80% of the variance could be predicted from the teachers' PCK. Let's look at the ANOVA summary of the model for statistical test of significance.

Table-13: Regression ANOVA summery:

ANOVA[b]						
Model		Sum of squares	df	Mean square	F	Sig.
1	Regression	561.802	1	561.802	16.607	.000[a]
	Residual	7577.422	137	33.827		
	Total	8139.224				

a. Predictors: (Constant), PCK		
b. Dependent variable: Academic achievement		

Table-13 where regression ANOVA summary for prediction of academic achievement of private school students from the mean scores of teachers' PCK has been presented, reflects that the regression model was statistically significant, F(1, 137)=16.607, p< .01. Let's look at the contribution of the variable presented in the table-14.

Table-14: Coefficients of regression:

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	Constant	59.157	3.123		18.935	.000
	PCK	.180	.044	.262	4.074	.000
Dependent variable: Academic achievement						

In the Table-14 the independent variable teachers' PCK made statistically significant contribution (Beta=.262, t=4.074, p< .01) in explaining the academic performances by the students of private schools. Therefore, the null hypothesis having no significant impact of teachers' PCK towards the use of technology on academic achievement of private school students in mathematics is rejected. Moreover, the Table gives raise to the regression equation y= 59.157+.180x for predicting academic achievement (y) with the help of teachers' PCK (x).

6. Conclusion:

In the study, from the students' perception, no significant difference has been found between teachers' pedagogical content knowledge towards the use of technology in digital and traditional classrooms. But there is a significant difference between the teachers' PCK in govt. as well as private schools within the study area. Moreover, teachers' PCK towards use of technology has a significant impact on the students' academic performances in the subject.

Teachers' pedagogical content knowledge plays a significant role in teaching and learning sessions. This primary component of teaching enhances effectiveness of the sessions with fruitful learning outcomes. If pedagogical content knowledge is technologically equipped and enriched with content fit materials then a new dimension could be created in the ambiance of teaching and learning.

References:

1. Anderson, M. A. (2000). It's in the research. Library Talk, 13(1), 31-33.
2. Yusuf, M. O. (2005). Information and communication technology and education: analysing the Nigerian national policy for information technology. International Education Journal, vol. 6, no. 3, pp. 316 – 321.
3. Basargekar, P. &Singhavi, C. (2017). Factors affecting teachers' perceived proficiency in using ICT in the classroom. IAFOR Journal of Education, vol. 5, no. 2, pp. 67-84.
4. Iwu, A. O. (2006). Perspectives on education technology Owerri, Peace Publishers Ltd.
5. UNESCO (2018). UNESCO, Effective and appropriate pedagogy, IIEP Learning Portal (2018).
6. Mishra, P. (2008). TPACK. (online). Accessed at http//www.punya.educ.msu.edu/ research/tpck
7. Grossman, P. (1990). The Making of a Teacher: Teacher Knowledge and Teacher Education. New York: Teachers College Press.
8. Cohen, D., 1986. Assessing the Quality of Teacher Education. East Lansing, MI: National Centre for Research on Teacher Education.
9. Doyle, W. (1986). Classroom organization and management.In M. C. Wittrock (Ed.), Handbook of research on teaching.A project of the American Educational Research Association (3rd ed., pp. 392– 431). New York, NY: Macmillan.
10. Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. Educational Researcher, 15(2), 4–14. https://learningportal.iiep.unesco.org/en/issue-briefs/improve-learning/teachers-and-pedagogy/effective-and-appropriate-pedagogy Google Scholar
11. Mishra, P., & Koehler, M.J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. Teachers College Record, 108(6), 1017–1054. doi:10.1111/j.1467- 9620.2006.00684.x
12. Clark, C. (2013). A phenomenological study of the impact of pre-service and in-service training regarding the integration of twenty-first century technologies into selected teachers' instruction. (Unpublished Doctoral dissertation, Liberty University). Retrieved from http://digitalcommons.liberty.edu/cgi/viewcontent.cgi?article=1734&context=doctoral
13. Shin, T. S., Koehler, M. J., Mishra, P., Schmidt, D. A., Baran, E., & Thompson, A. D. (2009). Changing Technological Pedagogical Content Knowledge (TPACK) through course experiences. In I. Gibson, R. Weber, K. McFerrin, R. Carlsen, & D. A. Willis (Eds.), Society for Information Technology and Teacher

Education International Conference book, 2009 (pp. 4152–4156). Chesapeake, VA: Association for the Advancement of Computing in Education (AACE).
14. Mc.Graw-Hill(2019). McGraw-HillWhat is TPACK theory and how can it be use in the classroom, www.mheducation.ca/blog/what-is-tpack-theory-and-how-can-it-be-used-in-the-classroom/ (2019)
15. Archambault, L., &Crippen, K. (2009). Examining TPACK among K–12 online distance educators in the United States.Contemporary Issues in Technology and Teacher Education, 9(1). Retrieved August 28, 2009,
16. Cox, S., & Graham, C. R. (2009). Diagramming TPACK in practice: Using and elaborated model of the TPACK framework to analyse and depict teacher knowledge. TechTrends, 53(5), 60–69.
17. Graham C.R. (2011) Theoretical considerations for understanding technological pedagogical content knowledge (TPACK). Computers & Education 57, 1953–1960.