Original Research Article

PEDAGOGICAL INNOVATION OF TPACK BASED K-4 LEARNING TRANSACTION MODEL IN SCIENCE AND SOCIAL SCIENCES

ABSTRACT

Technological Pedagogical Content Knowledge (TPACK) has been proposed as a 'conceptual framework' to describe the knowledge base that teacher needs for effective technology integration. Looking at the vitality of the concerns an experiment on the TPACK-based Practice Teaching Programme with reference to the learning achievement of students was carried out. The sample comprised of 40 student-teachers belonging to science and social science of the first batch integrated B.Ed program of Ravenshaw University and 341 students of CBSE-affiliated schools of Cuttack City. The scheme of the experiment was carried out by adapting Solomon Four Group Design. The quantitative data gathered through achievement tests were analyzed using Mean, SD, One-way ANOVA, and t-test. Based on the feedback given by the pre-service teachers, the project team brought in the innovation of the TPACK-based K-4 Learning Transaction Model (K4 -LTM). The data relating to innovation on TPACK-based K4 -LTM were collected through the reaction scale and analyzed by using percentage analysis. The findings revealed that there was a significant effect of the TPACK-based practice in teaching science and social science. The reaction of student teachers towards innovative TPACK-based K4 -LTM was found to be effective.

Keywords: TPACK, Practice Teaching Programme in Science and Social Science, Learning Achievement, Reaction, Innovation of K-4 Learning Transaction Model

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1. INTRODUCTION)

Information and Communication Technology (ICT) Competency Standards for Teachers (UNESCO, 2008) emphasize that teachers need the knowledge to use ICT for supporting constructivist learning which involves knowledge construction and problem-solving activities within authentic contexts (Airasian& Walsh, 1997; Duffy & Cunningham, 1996). This can be understood as a kind of technological pedagogical content knowledge (TPACK), which has been used by Mishra and Koehler (2006) to describe

teachers' knowledge about information and communication technology integration. Empirical studies show that practicing teachers do not fully exploit the affordances of ICT tools for constructivist teaching (Lim & Chai, 2008; Starkey, 2010; Webb & Cox, 2004); indicating that constructivist-oriented TPACK could be an area of challenge for them. Teachers' efficacy perceptions had a significant positive influence on their adoption of ICT (Wozney, Venkatesh, &Abrami, 2006). Insights for teacher professional development in ICT can be derived through a better understanding of their constructivist-oriented TPACK perceptions and the factors that can influence them. Nevertheless, their perceived knowledge gaps in this area are not well understood as published studies have only examined teachers' TPACK perceptions with respect to science education, e-learning facilitation, social studies, and mathematics (e.g., Archambault& Barnett, 2010; Graham et al., 2009; Lee & Tsai, 2010; Schmidt et al., 2009).

Technological Pedagogical Content Knowledge (TPACK) is currently considered as an essential framework for promoting instructional competency of 21st-century teachers. Technological Pedagogical Content Knowledge (TPACK) has been proposed as a conceptual framework to describe the knowledge base teachers need for effective technology integration. The issue of what teachers need to know about technology for effective teaching has been the centre of intense debate in the recent past. Teaching with technology for a given content matter is complex and multidimensional. It requires understanding the representation and formulation of concepts using technologies; pedagogical techniques that utilize technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help address these issues; knowledge and theories of epistemology; and an understanding of how technologies can be utilized to build on existing knowledge and to develop new or strengthen old epistemologies (Koehler et al. 2007, p. 743). Similarly, the extension of pedagogical and content knowledge (PCK) with the integration of technology became a domain of knowledge for teaching-learning practices (Shulman, 1986, 1987). However, technological integration changes the process of pedagogy, not the content. Thus, pedagogy that is practically useful in terms of how we teach? Mishra and Koehler (2006) had given a hybrid concept on teachers' knowledge about technology, pedagogy, content, and its contextual influence on learning. Harris and Hofer (2011) questioned how to do knowledge about technology, pedagogy, and content influences the teacher's instructional planning, activities and as a results technology integration in content enhances students' learning and classroom activities. According to Schmidt et, al. (2009) and Tokmak et.al (2013) pre-service teachers need to know the effective integration of technology into their teaching practices. Therefore, a symbiotic development in terms of knowledge of technology, pedagogy, and content is in need and demands of the time.

The prevailed situation in pre-service teacher education has been complex with the flood of innovations around and hence it requires appropriate directions, which appears to be neglected over the recent times. There is need of trained human resources to cope up with given gamut of challenges posed on teaching learning endeavors. This project c an attempt to look at certain possibilities which may give a direction on adoption of suitable technological and pedagogical approaches to deal with content. It is imperative therefore to moot the pertinent questions such as 1. What are the TPACK practices existing in practice teaching in pre-service teachers? 2. What are the existing levels of Technological Pedagogical and Content Knowledge among pre-service teachers? 3. To what extent the pre-service teachers need Technological Pedagogical and Content Knowledge? 4. To what extent TPACK based practice teaching could be effective? 5.What could be the reaction of preservice teaching teachers belonging to science and social science discipline towards TPACK based practice teaching? This genre of study can be an attempt to look at certain possibilities which may give a direction on adoption of suitable technological and pedagogical approaches to deal with contents in practice teaching Programme.

2. OBJECTIVES AND METHODS:

1. To study the effectiveness of TPACK based practice teaching in science with reference to learning achievement of students.
2. To study the effectiveness of TPACK based practice teaching in social science with reference to learning achievement of students.
3. To innovate and validate a suggestive TPACK based K-4 Learning Transaction Model (K-4 LTM) for improvement in practice teaching in science and social science with reference to reaction of pre-service teachers.

Hypotheses

1.1 There exists no significant difference between the mean Pre-test learning achievement score obtained by both experimental group-1 and control group-1 of science and social science students.

1.2 There exists no significant difference between the mean Post-test learning achievement score obtained by both experimental group-1 and control group-1 of science and social science students.

1.3 There exists no significant difference between the mean Post-test learning achievement score obtained by both experimental group-2 and control group-2 of science and social science students.

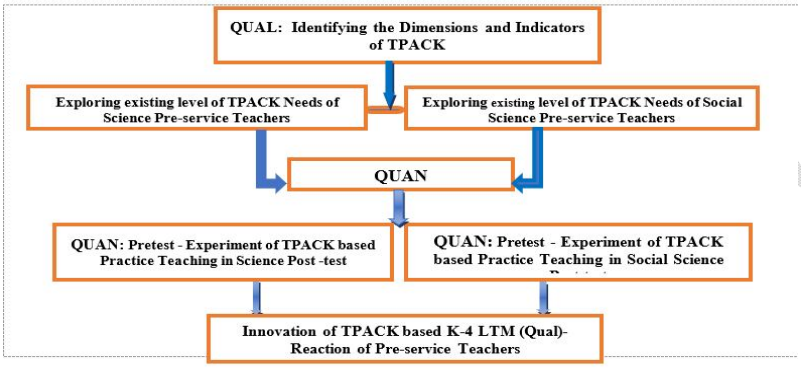
1.4 There exists no significant difference between the mean Post-test learning achievement score obtained by both experimental group-1 and experimental group-2 of science and social science students.

1.5 There exists no significant difference between the mean Post-test learning achievement score obtained by both control group-1 and control group-2 of science and social science students.

2. METHODOLOGY

Comment [L4]: The methodology does not fully discuss the type of research, research subjects, instruments, data collection techniques, and data analysis used.

Figure 1 : SCHEMATIC DIAGRAM OF STUDY DESIGN (MIXED METHOD EMBEDDED DESIGN)



Matching to the objectives, the study has employed mixed method design especially the embedded mixed methods design (Creswell, 2014, Morgan,2019) used to explore the preliminary qualitative study to support for a primary quantitative study. Further this quantitative study has been supported with a qualitative study. This is a mixed methods of Qual - Quant - Qual. Thus, both quantitative and qualitative data have been put on primary focus on the study. The study has been conducted in three phases as guided by the above design.

Phase-I: In first phase TPACK specific practices by the preservice teachers was explored. Then the existing status of TPACK knowledge and TPACK needs of Social Science and Science pre-service teachers have been explored and data have been analyzed both qualitatively and quantitatively.

Phase-II: The first phase of the study supported to the second phase of the study in which a TPACK orientation was given to the selected pre-service teachers leading to experiments in their practice teaching in both science and social science. Solomon four group experimental design was adopted for effectiveness of TPACK based practice teaching programme with reference to learning achievement. TPACK based practice teaching programme was experimented at school level in real classroom situation.

Phase-III: In third phase less understood aspects of the in existing TPACK practices were explored and suggestive instructional design within the TPACK-5 framework was innovated.The data related to reaction of preservice teachers belonging to science and social science towards

innovated TPACK-5 based K-4 lesson plan were collected through Technological, Pedagogical and Content Knowledge (TPACK) Reaction Scale.

3. RESULTS AND DISCUSSION

The effectiveness of TPACK based practice teaching with reference to Learning achievement of students were analyzed and interpreted as follows

Table 1: Description of Posttest score ofexperimental and control group of science and social science (Full Marks-25)

Test	Subject	Group	N	Mean	Std. Deviation
Pre-Test	Science	Experimental Group 1	60	14.03	1.10
		Control Group 1	35	15.24	2.55
	Social Science	Experimental Group 1	60	17.09	12.45
		Control Group 1	38	13.89	2.41
Post-test	Science	Experimental Group 1	60	21.25	.94
		Experimental Group 2	39	22.01	1.21
		Control Group 2	35	17.71	1.28
		Control Group 2	36	16.20	1.81
	Social Science	Experimental Group 1	60	22.27	1.20
		Experimental Group 2	39	22.16	1.88
		Control Group 2	38	17.59	1.99
		Control Group 2	34	17.02	2.32

Table 2: T-test for Pre-test of Experimental group and Control group in Science (N=95)

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. \ (2-tailed)	Mean Difference	Std. Error Difference
PreTest	Equal variances assumed	16.889	.000	-3.192	93	.002**	-1.2031	.37692
	Equal variances not assumed			-2.653	41.508	.011**	-1.2031	.45346

** Not Significant at both level

Table 3 ANOVA for Posttest of Experimental group and Control group in Science (N=170)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	929.831	3	309.944	183.513	**.000***
Within Groups	280.366	166	1.689		
Total	**1210.197**	**169**			

*Significant at 0.05 level

Table 4 T-test for Pre-test of Experimental group and Control group in Social Science (N=98)

	Group	Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. \ (2-tailed)	Mean Difference	Std. Error Difference
Pre-Test	Equal variances assumed	10.764	.001	3.329	96	**.001**	1.227	.3688
	Equal variances not assumed			3.031	.001	**.004**	1.227	.4049

Table 5 ANOVA for Posttest of Experimental group and Control group in Social Science (N=171)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1009.046	3	336.349	103.297	**.000***
Within Groups	543.775	167	3.256		
Total	**1552.821**	**170**			

*Significant at 0.05 level

i. TPACK based practice teaching in science the pre-learning achievement of students was found to be effective by retaining the null hypothesis between experimental and control groups. In other words, it can be said that the science students of experimental group-1 and control group-1 were found to believe to the same extent in their learning achievement score.

ii. Thepost-test mean score of learning achievement of science students of experimental group-1 and experimental group-2 did not differ significantly. In other words, it can be said that the experimental group-1 taught by TPACK based practice teaching found equal to their counterpart experimental group 2 taught by the same approach TPACK based practice teaching.

iii. The mean score of learning achievement of science students of control group-1 and control group-2 did not differ significantly. In other words, it can be said that the control group-1 taught by traditional approach-based practice teaching found equal to their counterpart control group-2 taught by same traditional approach-based practice teaching.

iv. TPACK based practice teaching in science, the post-learning achievement of students was found to be effective by rejecting the null hypothesis between experimental and control groups and did not differ significantly. Thus, it can be said that the experimental groups (1&2) taught by TPACK based practice teaching found superior to their counterpart control groups (1&2) taught by traditional approach-based practice teaching.

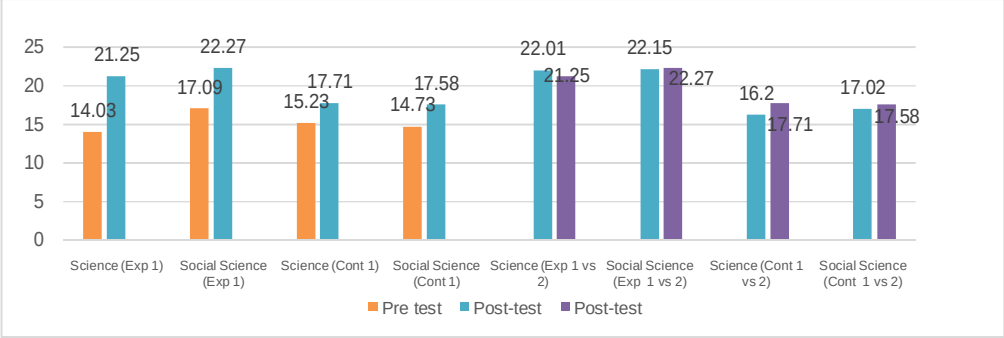


Figure 2:Pre-test, Post-test Mean Score in Science and Social Science (Class VII)

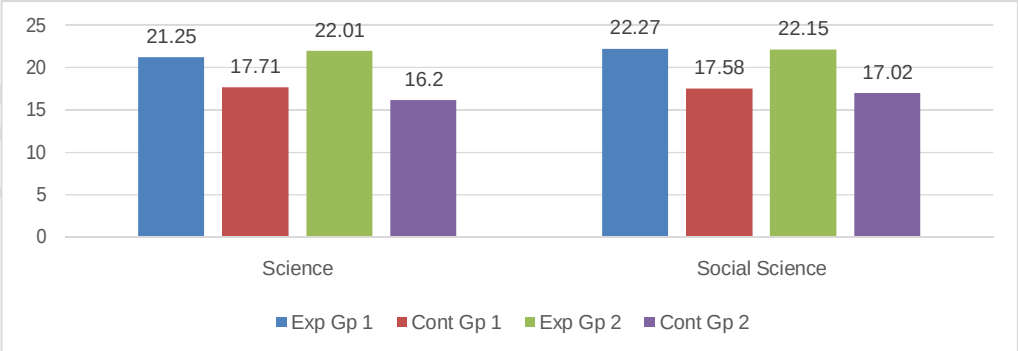


Figure 3:Post-test Mean Score in Science and Social Science (Class VII)

v. TPACK based practice teaching in social science with reference to the pre-learning achievement of students was found to be effective by retaining the null hypothesis between experimental and control groups. The mean score of learning achievement of science students of experimental 1 and control group-1 did not differ significantly. In other words, it can be said that the experimental group and control groups found to be equal in pre-test achievement score.

vi. The mean score of learning achievement of social science students of experimental group-1 and experimental group-2 did not differ significantly. In other words, it can be said that the experimental group-1 taught by TPACK based practice teaching found equal to their counterpart experimental group 2 taught by the same approach TPACK based practice teaching.

vii. The mean score of learning achievement of social science students of control group-1 and control group-2 did not differ significantly. In other words, it can be said that the control group-1 taught by traditional approach-based practice teaching found equal to their counterpart control group-2 taught by same traditional approach-based practice teaching.

viii. TPACK based practice teaching in social science the post-learning achievement of students was found to be effective by rejecting the null hypothesis between experimental (1&2) and control groups (1&2) did not differ significantly. Hence, it can be said that the experimental group taught by TPACK based practice teaching found superior to their counterpart control group taught by traditional approach-based practice teaching.

4. Innovation On $TPACK_5$ Based 'K_4 Learning Transaction Model' For Improvement in Practice Teaching In Science And Social Science With Reference To Reaction Of Pre-Service Teachers

- For $TPACK_1$ and $TPACK_2$<60% of student teachers found it most useful, $TPACK_3$ and $TPACK_5$<50%, and $TPACK_4$ 48% found it most useful in science teaching.
- For $TPACK_3$<60% of student teachers found it most useful, followed by $TPACK_1$ and $TPACK_5$<50% $TPACK_2$ and $TPACK_4$,48% found it most useful in social science teaching.

INNOVATED TPACK BASED K-4 LEARNING TRANSACTION MODEL (K-4)

- Knowledge Tension: Contextualization *(Pedagogy involved: Situated cognition- consciously igniting cognition in learners'own observation, learning and skills)*
- Knowledge Presentation- acquisition *(Pedagogy involved: Anchored Instruction- integrating technology in learning approaches which place learning within meaningful and problem-solving context, Contextualized discursion- reflecting logically beyond the content and context)*
- Knowledge Collaboration- extension (*Pedagogy involved: Disrupted Collaboration- awakening the mind by posing questions begin with how, why and if, whilecontributing in group)*
- Knowledge check-evaluation ((*Pedagogy involved: Constructed Manifestation- interpreting and manifesting while linking the whole to learners' own experiences and applications)*

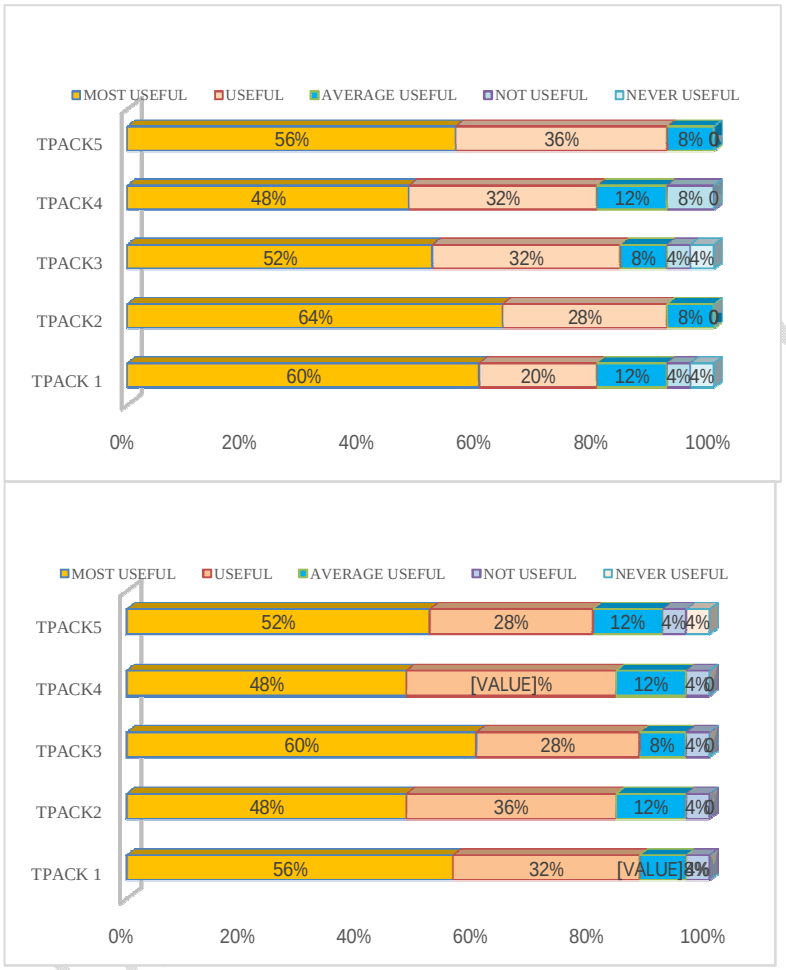


Figure 4:Reaction of Science Preservice Teachers towards TPACK5 Components used for K4 Instructional Design

5. CONCLUSIONS AND IMPLICATIONS

1. There is significant difference between the experimental group-1 and control group-1. Further, there is significant difference between the experimental group-2 and control group-2. In both the experiments mean score of learning achievement of experimental group-1 &2 was found higher than the mean score of learning achievement of control group-1 &2. Further, there is a negligible difference found between the experimental group-1 & 2 and control group-1 & 2 as well. In other words,

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it can be said that TPACK based practice teaching was found superior to traditional approach-based practice teaching.

2. The study reveals that TPACK based practice teaching was found superior to traditional approach-based practice teaching with reference to learning achievement of students. It is imperative therefore to provide rigorous orientation exposure on TPACK practices and development and use of TPACK based Lesson Plans for preservice teachers facilitated by the teacher educators and concerned teacher education institutions.
3. It was also revealed that TPACK based practice teaching was found effective in both science and social science teaching. Therefore, research and training may be undertaken to experiment TPACK based practice teaching effectiveness in other subjects like languages and mathematics.
4. The study also brought in an innovation in TPACK based lesson plans on the basis of feedback given by the preservice teachers and the teacher educators engaged in the process of experiment. This innovated instructional design is K-4 Learning Transaction Model based on TPACK guidelines developed by the project team. This innovated instructional design may be called as TPACK based K-4 Learning Transaction Model (K-4 LTM). Similar innovations may be carried out by other researchers and teacher educators.
5. Further the study revealed that 85.6 per cent science preservice teachers and 84.8 per cent social science preservice teachers responded their favorable reaction towards TPACK based K-4 Learning Transaction Model (K-4 LTM). Hence it can be suggested that this genre of TPACK based K-4 learning transaction model may be recognized for use in practice teaching organized by teacher education programmes at secondary and even elementary level. This model may be useful in day-to-day real teaching at school level and even in education delivery at higher stage.
6. At policy level the NCTE, NCERT, SCERT, DIET and the PMMMNMTT need to conduct a greater number of project experiments and formulate necessary guidelines for TPACK practices at preservice practice teaching level. Also, the government agencies like state level school and mass education departments need to conduct in-service training on TPACK based teaching to empower teachers at school level. The government must provide technology infrastructure at school level and teacher education institution level to make TPACK based teaching successful and useful.

7. In addition, it can be suggested an innovative TPACK based K-4 instructional design that could also be used to train the preservice teachers to examine whether there is a shift towards the use of technology to construct knowledge namely TPACK to strengthen the teacher education standards, which could reflect a deeper understanding

for the teacher education institutions for developing insight to teaching and learning.

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Comment [L6]: 1.it would be nice if the references used were from the last 10 years in order to provide the latest information on scientific developments.

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