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Redefining Teaching Competency in the Digital Age: The Contribution of TPACK

Ms. Archana Singh[1],
Research Scholar,
School of Education, Galgotias University[1]
Dr. Navita Malik[2]
Professor,
School of Education, Galgotias University[2]

ABSTRACT:
In the digital age, the traditional concept of teaching competency is undergoing major reformation owing to technology breakthroughs and shifting educational paradigms. The Technological Pedagogical Content Knowledge (TPACK) framework has developed as a critical approach for incorporating technology into the classroom. This study investigates the importance of TPACK in redefining teaching competency, focussing on its effects on pedagogical practices and overall teaching performance. The study demonstrates how TPACK enables educators to construct dynamic, interactive, and learner-centered settings by investigating the relationship between technology, pedagogy, and content knowledge. The research is a quasi-experiment design of a pretest and posttest control group. A sample of 60 pupil teachers of the science stream, was selected using a purposive sampling technique. For intervention, TPACK-based lesson plans were used to teach the experimental group and the conventional method for the control group. A self-developed teaching competency scale was used to collect data. Statistical techniques like Mean, Standard Deviation (SD) and t-test were used to provide meaningful interpretations, and conclusions of the investigation. The findings show that TPACK increases teachers' technical skills while enriching their pedagogical tactics, resulting in a more versatile and capable teaching workforce.

Keywords: *TPACK, teaching competency, pupil teacher, quasi-experimental, pedagogical tactics.*

Introduction:

The rapid growth of technology has altered the educational landscape, prompting a transformation in instructors' competencies. Traditional teaching methods, while still essential, must be supplemented with digital resources and creative pedagogical approaches to satisfy the different demands of 21st-century learners. In this context, Mishra and Koehler's (2006) Technological Pedagogical Content Knowledge (TPACK) paradigm serves as a comprehensive model for incorporating technology into teaching. TPACK focuses on the node of three basic knowledge domains: content knowledge (CK), pedagogical knowledge (PK), and technical knowledge (TK). By bringing these factors together, educators may create more interesting, effective, and personalised learning experiences. Teaching competency in the digital era goes beyond topic knowledge and instructional abilities to include the capacity to effortlessly integrate technology into the teaching-learning process. This integration necessitates not only competency with digital technologies, but also a grasp of how to use them in pedagogically sound ways that improve student learning results. The TPACK framework encounters this requirement by supporting teachers in deciding, modifying, and implementing technology to complement their teaching objectives.

The purpose of this study is to investigate how the TPACK framework helps to redefine teaching competency in modern education. It investigates the effect of TPACK on instructors' abilities to plan and deliver technology-enhanced lessons, nurture scientific attitudes, and

increase students' critical thinking skills. By looking into the relationship between TPACK and teaching performance, the study hopes to provide actionable insights for teacher education programs, policymakers, and educators working to fulfil the demands of the digital age.

Literature Review:

Sadik (2021) described the relationship between pedagogy, content, and technology, is critical for educating future instructors in technology integration and other education courses. The Technological Pedagogical Content Knowledge (TPACK) framework has emerged as a valuable model, guiding educators in seamlessly blending technology with pedagogy, and content knowledge (Koehler, 2013). Gonzalez and González-Ruiz (2017) revealed that the TPACK level of pre-service affects teachers' behavioral intention to include technology in their classroom instruction. Similarly, Huang and Lajoie (2021) highlighted the significance of Self-Regulated Learning (SRL) in achieving TPACK, a fundamental component of effective technology integration.

(Chai, Koh, & Tsai, 2013) investigated pupil teachers while learning about different technologies that can be used for designing lessons for a specific subject and for delivery of classroom instruction, they have experienced the potentials offered by technology as well as the limitations it carries in the classroom (Koehler & Mishra, 2005). Teacher training institutes need to adopt strategies to enhance the TPACK of the teachers as the TPACK framework can assist teachers in their professional development in the era of rapid technological development (Lee et al., 2022). The TPACK model can significantly promote teachers' training and in their educational work also(Ortiz-Colón et al., 2023). Sharma, Hemant & Sharma, Leena. (2018) studied that there was a significant rise in the TPACK scores through ICT Programme intervention as the students learned more. Similar research by Soko and Samo (2023) stated that both teaching and training experience were found to have a positive influence on teachers' TPACK. teaching expertise requires effective training for persons desiring to contribute to national or global well-being. While the majority of studies in this sector have been undertaken in Western countries, India has only seen a small proportion of them. Furthermore, an examination of the literature on technology integration with TPACK reveals an absence of comprehensive research in this field. These circumstances led the researcher to conduct the current investigation.

Objectives:

- To study and compare the mean scores of Teaching Competency of the control and experimental group before the experiment.
- To study and compare the mean scores of Teaching Competency of the control and experimental group after the experiment.
- To compare the mean gain scores of Teaching Competency of the control and experimental group after the experiment.

Hypotheses:

- No significant difference exists in the Teaching Competency mean scores of the control and experimental group before the experiment.
- No significant difference exists in the Teaching Competency mean scores of the control and experimental group after the experiment.
- No significant difference exists in the Teaching Competency mean gain scores of the control and experimental groups after the experiment.

Methodology:

Research Design

The type of research was quasi-experiment. The quasi-experimental methods that involve the creation of a comparison group are most often used when it is not possible to randomize individuals or groups in treatment and control groups. The research design was required to apply the pretest-posttest control group (Sugiyono, 2012). The sampling technique used to collect data is purposive sampling.

Population and Sample

In the present study Pupil teachers of Gautam Budh Nagar district represent the population. In this study 60 pupil teachers of pedagogy of science studying in Teacher Education Institute were taken as sample. From the sample, two groups of 30 pupil teachers in each group were made. One is the Control group(C) and the other is the Experimental group (E).

Variables involved

The dependent variable for this study is Teaching Competency. The study's independent variable is TPACK, which is being directed to study its effect on Teaching Competency.

Tools Used

- **Teaching Competency Scale**

  The teaching Competency Scale was developed by the researcher on a 5-point Likert Scale. There were a total of thirty items in the scale. The Spearman-Brown Split Half Method was used to calculate the reliability coefficient and came out as 0.942.

The validity of the questionnaire was determined by getting valuable suggestions and feedback from experts.

Statistical Techniques

For data analysis and interpretation following techniques were used

- Mean
- Median,
- SD and t-test.

Research Procedure

In the present study, TPACK-based lesson plans were used for teaching pupil teachers of experimental group. The TPACK-based lesson plans included animated pictures, video clips, text, app links etc. Pupil teachers in the control group were taught through conventional methods i.e. using a chalkboard, Audio-visual aids, etc. Quasi-experimental research design shares a resemblance with the experimental design but quasi-experimental design specifically differs in terms of the random assignment of elements. Quasi-experimental designs typically allow the researcher to control the assignment to the treatment condition but using some criterion other than random assignment.

A non-randomized control Group Pre-test Post-test Quasi-Experimental Design was used for the study. The experimental group was taught through TPACK-based lesson plans and the control group was taught through the conventional method. The table shows the three phases of carrying out the experiment.

Table 1

Phase 1- Pre-test	Phase 2- Intervention	Phase 3- Post-test

Pre-test scores of Teaching Competency	Teaching with a TPACK-based lesson plan.	Post-test scores of Teaching Competency
Pre-test scores of Teaching Competency	Teaching with the conventional lesson plans.	Post-test scores of Teaching Competency

This experimental procedure was well organized in three phases as given here:

PHASE-I: Pre-Test: A sample of 60 pupil teachers was selected by using the purposive sampling technique to facilitate experimental intervention by using TPACK based lesson plan. From the sample size, two groups were made(a control group and an experiment group) of 30 pupil teachers in each group. A Pre-test was administered to both groups by using the research tool, Teaching Competency scale before initiating the planned intervention. The scores obtained through the pre-test were preserved.

PHASE-II: Intervention: The second phase of the experiment was the real execution of the experiment. In this phase, the experimental group was given treatment by teaching pedagogy of science with TPACK-based lesson plan, and the control group was taught by the conventional method of teaching. The intervention treatment was given to the experimental group, whereas the control group was taught by the conventional method for the same period. The same content was taught to both groups.

PHASE-III: Post-test: Both the groups, control group, and experiment group were tested again after the intervention. The research tool was administered again to obtain the post-test scores. The scores obtained through the post-test were also preserved to compare with scores on the pre-test thereby the researcher can appraise the effectiveness of the intervention.

Results:

Objective 1: To study and compare the mean scores of Teaching Competency of the control and experimental group before the experiment.

Hypothesis(H_{01}): No significant difference exists in the Teaching Competency mean scores of the control and experimental group before the experiment.

Table 2

Mean scores of Teaching Competency scores of control and experimental group(before experiment)

Group	N	Mean	S.D	t-value
Control Group (C)	**30**	50.4333	5.869	**0.2650**
Experimental Group (E)	**30**	50.0333	5.8222	

Interpretation:

From the above table 2, it can be seen that the t-value 0.2650 is non-significant at 0.05 level of significance. Hence, the null hypothesis "No significant difference exists in the Teaching Competency mean scores of the control and experimental group before the experiment" was accepted. This shows that the teaching competency scores of both the control and experimental group were same before the experimental treatment.

Objective 2: To study and compare the mean scores of Teaching Competency of the control and experimental group after the experiment.

Hypothesis (H_{02}): No significant difference exists in the Teaching Competency mean scores of the control and experimental group after the experiment.

Table 3

Mean scores of Teaching Competency of control and experimental group (after experiment)

Group	N	Mean	S.D	t-value
Control Group (C)	**30**	72.466	4.41	
Experimental Group (E)	**30**	87.867	3.537	**14.922**

Interpretation

From the Table 3 above, it is evident that t-value 14.922 is significant at the 0.01 level. It shows that the Teaching Competency scores of the control and experimental groups after the experiment differ significantly. Hence, the null hypothesis "No significant difference exists in the Teaching Competency mean scores of the control and experimental group after the experiment" was not accepted. The result showed that TPACK has a positive influence after treatment. Cheung(2006) found that the integration of ICT has a positive impact on teaching effectiveness. Hence, it can be concluded that after intervention, pupil teachers' teaching competency enhanced significantly.

- **Objective 3:** To study and compare the mean gain scores of Teaching Competency of the control and experimental group after the experiment.

- **Hypothesis(H_{03}):** No significant difference exists in the Teaching Competency mean gain scores of the control and experimental group after the experiment.

Table 4

Mean Gain scores of Teaching Competency of experimental and control group

Group	N	Pre-Test Mean	Post-test Mean	Mean Gain	S.D	t-value
Control Group (C)	**30**	50.4333	72.466	**22.033**	**7.294**	**8.396**
Experimental Group (E)	**30**	50.0333	87.867	**37.834**	**7.285**	

Interpretation:

From table 4 above, it can be seen that t—value 8.396 is significant at the 0.01 level. It shows that the mean gain scores of Teaching Competency of the control and experimental group after intervention differ significantly. Hence, the null hypothesis "No significant difference exists in the Teaching Competency mean gain scores of the control and experimental group after the

experiment" was not accepted. It signifies that the mean gain scores of Teaching Competency of both the control and experimental group differ significantly after experimental treatment.
The results of the study were aligned by the findings of Ahmet Oguz Akturk(2019) who revealed that the teachers' use of TPACK positively impacts students' academic achievement. Hence, the findings of the study and the other research help to conclude that the use of TPACK based approach enhances teaching competency more than the conventional approach.

Discussion:

H_{01} : There is no significant difference in Teaching Competency scores of the control and experimental group before the experiment.

Result : After the analysis, the result shows that there has been no significant difference in Teaching Competency scores of the control and experimental group before the experiment. Hence, the hypothesis stands accepted.

The lack of significant difference in the initial Teaching Competency scores indicates that the groups were adequately matched in terms of their baseline abilities and skills. This suggests that any subsequent differences observed during or after the intervention can be attributed to the experimental treatment rather than pre-existing disparities. The result also highlights the effectiveness of the randomization or matching process employed during the group selection, ensuring internal validity in the study design.

H_{02} : There is no significant difference in Teaching Competency scores of the control and experimental groups after the experiment.

Result : After the analysis, the results shows that there has been a significant difference in Teaching Competency scores of the control and experimental groups after the experiment. Hence, the hypothesis stands rejected.

The findings indicate that the intervention applied to the experimental group had a positive and measurable impact on their Teaching Competency compared to the control group. The observed improvement in Teaching Competency in the experimental group suggests that the intervention introduced techniques that were effective in enhancing pedagogical skills, classroom management, instructional methods, or other key dimensions of teaching. Several studies align with these findings, highlighting the positive effects of targeted interventions on Teaching Competency. For example, a study conducted by **Patel and Mehta (2021)** found that integrating technology into teacher training programs leads to substantial improvements in Teaching Competency, particularly in areas such as lesson planning and interactive teaching methods

H_{03} : There will be no significant difference in the mean gain Teaching Competency scores of the control and experimental groups.

Result : After the analysis, the result shows that there has been a significant difference in the mean gain Teaching Competency scores of the control and experimental groups. Hence, the hypothesis stands rejected.
The finding indicates that the intervention implemented in the experimental group was effective in enhancing Teaching Competency compared to the control group. The substantial improvement in Teaching Competency scores of the experimental group suggests that the intervention provided meaningful opportunities for professional growth. This improvement may have resulted from the integration of innovative teaching strategies, reflective practices, collaborative learning, or technology-enhanced methodologies. The structured and focused

nature of the intervention likely enabled the experimental group to refine their pedagogical skills, enhance classroom management abilities, and adopt more effective instructional approaches.

Conclusion:

With the application of TPACK, pupil teachers' confidence, and creativity are being built so that they can spend time investigating the ability to connect concepts through digital tools and resources in different ways. This, in turn, will help them to empower students not only through the mastery of the academic content but also through the effective use of technology in their navigation of 21st-century classrooms.

Finally, the TPACK framework is one of the most important resources for the professional development of pupil teachers. It forms the idea of long-term thinking, it extends the areas of teaching, and it gives various tools and knowledge to both instigate and move forward the learning with the help of technologies. By institutionalizing TPACK into the teacher education curriculum, schools will be confident that their graduates will be capable of promoting scientific literacy, critical thinking, as well as technological and communication skills, which are indispensable for the holistic development of education.

This study will help teachers to learn new skills through collaborating with peers. It helps teachers to understand the value of TPACK in their professional life as it talks about core factors of teaching and their relation. Academic administrator will also realize the benefits of organizing TPACK training for their teachers to minimize the gap in technology integration with pedagogy and content.

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