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Original Research Paper

TEACHING COMPETENCY OF SCIENCE TEACHERS IN RELATION TO THEIR TECHNO-PEDAGOGICAL SKILLS AT SECONDARY LEVEL

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ABSTRACT

Science is viewed as a body of knowledge as well as a process of acquiring and refining knowledge. The 'search for truth' becomes the dominant motive and a hall-mark in the structure of 'science'. Facts alone find a place in the body of scientific information. Science is a dynamic, expanding body of knowledge covering ever new domains of experience. The laws of science are never viewed as fixed eternal truths. Even the most established and universal laws of science are always regarded as provisional, subject to modification in the light of new observations, experiments and analysis. Science plays an important role in the development of qualities of a person's head and heart, enabling him to become a useful and productive member of society. By practicing the scientific process, a person is trained in scientific methods and develops qualities of honesty, curiosity, creativity, objectivity and scientific attitude. Science creates an inherent curiosity to unfold all mysteries of man and nature. The science teachers working in secondary schools should develop necessary competencies and skills in teaching science, integrating technology in the content as well as pedagogical aspects. The present study is an attempt to examine the teaching competency of science teachers in relation to their techno-pedagogical skills in secondary schools. The researchers used a well-developed questionnaire as the tool for collection of data from a sample of 80 School Assistants in Science working in 80 selected secondary schools located in the rural as well as urban areas in East Godavari district of Andhra Pradesh using Stratified Random Sampling method. The data were analyzed using differential and inferential statistics. The findings of the study revealed that the demographic variables – Gender and Teaching Experience have no influence on the perceptions of teachers towards their competency in science teaching in relation to techno-pedagogical skills. However, 'Location of the school' has a significant positive influence on their competency in teaching science in relation to techno-pedagogical skills, with urban teachers perceiving higher as compared to their rural counterparts. The study suggested that science teachers in secondary schools should be given in-service training to integrate technology in teaching science.

Key words: ***Perceptions, Science Teachers, Techno-Pedagogical skills, Secondary Schools***

INTRODUCTION

Education is a comprehensive and systematic process through which individuals learn and acquire a broad range of knowledge, skills, attitudes and values necessary for personal and societal development. It begins from early childhood and continues throughout life, encompassing formal, non-formal and informal modes of learning. It equips learners with the tools and capabilities required to face real-life challenges, make informed decisions and adapt to an ever-changing world. Furthermore, education plays a vital role in shaping responsible citizens who actively participate in social, economic and civic life. It equips people with the tools to understand the world around, fostering critical thinking, creativity and a sense of curiosity that fuels continuous growth. It contributes to personal development by fostering self-awareness, emotional intelligence and a sense of identity. It encourages individuals to explore their interests, passions and values. It prepares them for their chosen careers and opens doors for their placement in an organization of their choice. It is a means for people to overcome socio-economic barriers and achieve upward social mobility.

SCIENCE EDUCATION IN SECONDARY SCHOOLS

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Science has entered into the very fabric of our everyday life; and without science, human existence on this earth is difficult. It creates and develops insights into the mysteries of natural existence that has always attracted people's attention since ages. In addition to satisfying man's intellectual curiosity and providing material and media for intellectual practice, science has a disciplinary effect on man's mind through its innumerable manifestations. Today there is no aspect of human life which is not influenced by science in one way or the other. Science has revolutionized every sphere of life and undoubtedly has done a great service to mankind.

Science education refers to the teaching and learning of scientific principles, concepts, methods and approaches in science systematically. It is essential for preparing individuals to understand and address global challenges, to participate in technological advancements and to take informed decisions in a scientifically driven world. It equips students with the necessary skills such as careful observation, perseverance, concentration, honesty and unbiased logical judgment. These qualities are useful to guide one to live as a skilled member in the society.

THE CONCEPT OF 'TECHNO-PEDAGOGICAL SKILLS'

Techno-pedagogical skills refer to the ability of teachers to effectively integrate technology with pedagogy, ensuring that digital tools are used not just for convenience; but to enhance teaching and learning outcomes. Instead of simply using technology for its own sake, these skills focus on how to use digital platforms such as Learning Management Systems (LMS), Multimedia tools and educational software to achieve specific learning goals. These skills are essential for 21st-century educators to make learning more engaging, accessible and personalized.

Techno-pedagogical skills can be understood as "the competencies teachers develop to combine technological knowledge (ICT tools, Digital platforms, multimedia) with pedagogical knowledge (teaching methods, learner psychology, curriculum design)".

Techno-pedagogical skills are to be developed by the science teachers to create a **technology-enhanced learning environment** that improves student engagement, supports diverse learning needs and prepares learners for a digital society.

The following are the key components of techno-pedagogical skills:

(i) **Content Knowledge:** A deep understanding of the subject matter being taught (strong grasp of science concepts, laws or theories).

(ii) **Pedagogical Knowledge**: An understanding of teaching methods and approaches, learning styles and instructional design (designing inquiry-based science lessons)

(iii) **Technological Knowledge**: The proficiency to use hardware, software and the internet in day-to-day teaching (using Google Classroom, Zoom, Microsoft Teams or interactive whiteboards)

TEACHING COMPETENCY OF SCIENCE TEACHERS IN RELATION TO THEIR TECHNO-PEDAGOGICAL SKILLS

In an era where technology is deeply embedded in educational practices, developing techno-pedagogical competency is essential for educators seeking to enhance their teaching effectiveness. This competency refers to the ability to integrate technological tools within pedagogical strategies and disciplinary content to improve student learning outcomes. Here are some key aspects to consider in developing this multifaceted competency.

(i) Understanding the TPACK-Framework

Familiarity with the Technological, Pedagogical and Content Knowledge (TPACK) framework is essential for every science teacher. Teachers should recognize how Content Knowledge (CK), Pedagogical Knowledge (PK) and Technological Knowledge (TK) interact. This understanding allows educators to envision and create innovative learning experiences that effectively leverage technology to support their instructional goals.

(ii) Content Knowledge Development

To effectively integrate technology, educators need a solid grasp of the subject matter they are teaching. This involves continuous professional development to stay updated on both the content itself and the latest advancements in the field. Educators should engage with ongoing learning opportunities that deepen their subject knowledge and encourage

interdisciplinary connections where technology can enhance understanding.

(iii) Pedagogical Strategies
Developing diversified pedagogical strategies is crucial for effectively utilizing technology in the classroom. This includes understanding different teaching methodologies—such as project-based learning, flipped classrooms, or collaborative learning—that can benefit from technology. Educators should experiment with various instructional approaches to find the best fit for their students' learning needs and preferences.

(iv) Technology Proficiency
Educators must be proficient in using various technological tools and platforms. This encompasses not only basic digital skills but also an understanding of how specific technologies can facilitate learning processes. Teachers should engage in professional development that focuses on emerging technologies, digital literacy, and best practices for technology integration.

(v) Assessment and Feedback
Assessment is an integral part of pedagogy. Developing techno-pedagogical competency involves knowing how to utilize technology for both formative and summative assessments. This includes using digital tools to track student progress, provide immediate feedback, and adjust instruction as needed. Educators can leverage data analytics and educational software to personalize learning and improve outcomes.

(vi) Creating a Supportive Learning Environment
Techno-pedagogical competency extends beyond individual knowledge; it also involves fostering a supportive learning environment that encourages student engagement and collaboration. Teachers should create a classroom culture where use of technology is normalized and where students feel empowered to explore and utilize digital resources.

(vii) Reflective Practice
Finally, developing techno-pedagogical competency requires ongoing self-reflection. Educators should regularly evaluate their practices, seek feedback, and engage in professional learning communities to share experiences and insights. Reflection helps educators assess the effectiveness of their technology integration and make informed adjustments to their teaching methods.

By focusing on these dimensions, educators can develop techno-pedagogical competencies that not only enhance their teaching; but also foster a more dynamic and interactive learning experience for their students. In doing so, they prepare learners for a rapidly evolving digital world, equipping them with the skills and knowledge necessary to thrive in the 21st century.

REVIEW OF RELATED STUDIES

A review of the related studies carried out in the field by the earlier researchers has been conducted; and a brief summary of the studies is provided in the following paragraphs.

Saket Bihari (2025) conducted a study to know the awareness of senior secondary school teachers towards techno-pedagogical competency skills, which are essential for effectively integrating technology into classroom practices. The study hypothesized that there would be no significant difference in the mean scores of senior secondary school teachers' awareness towards technology in preparing for teaching, providing motivation, presentation, evaluation and techno-pedagogical competency. The study used Descriptive survey method. A sample of 100 senior secondary school teachers from North West District of Delhi was randomly selected for the study. The techno-pedagogical competency scale developed by S. Rajasekhar and K. Sathiyaraj (2020) was used to collect data from the respondents. The data were analyzed using 't'-test. The study revealed no significant difference in the mean score values of male and female teachers on their awareness towards techno-pedagogical competency. However, there is significant difference in the mean score values of rural and urban school teachers on their awareness towards techno-pedagogical skills. Urban senior secondary school teachers have higher Techno-Pedagogical competency than their rural counterparts. Similarly, the results also revealed a significant difference in the mean score values of government and private school teachers on their awareness towards techno-pedagogical competency, with private senior secondary school teachers exhibiting higher techno-pedagogical competency as compared to their counterparts working in government senior secondary schools.

Jai Prakash & Hooda, S.R. (2018) conducted a study to compare the techno-pedagogical competency of private and government senior secondary teachers of Haryana state. Descriptive survey method was used for the present investigation. A sample of 200 teachers were selected from 40 schools (20 Private schools and 20 Government schools) using simple random sampling technique. The data were collected from the respondents using a questionnaire. The results of the study revealed that private school teachers have exhibited better techno-pedagogical competency as compared to government teachers. The study also revealed that urban teachers have more techno-pedagogical competency than the teachers working in rural higher secondary schools.

Pradeep Kumar, S.L. (2018) made a study to find out the techno-pedagogical skills of secondary school Hindi teachers working in Kerala. Finding has shown that secondary school teachers who are handling Hindi have good knowledge regarding techno-pedagogical skills. It is observed that male teachers had more techno-pedagogical skills than female teachers. Female teachers lag behind in the competency in utilizing the web facilities, confidence in using the IT devices effectively in the classroom, competency in inquiry based online learning and competency to develop the needed C.D's and other particulars. The study showed that the Techno-pedagogical skills of secondary school Hindi teachers were satisfactory.

NEED FOR THE PRESENT INVESTIGATION

In today's educational system, techno-pedagogical competency skills are very much essential on the part of the teachers to meet the demands of the learners of 21st century. When technology is used effectively in the classroom, students' learning is greatly improved. Teachers may design immersive and interesting learning experiences that encourage critical thinking and active learning by utilizing technology resources like interactive software, multimedia content and virtual simulations. Students now have easy access to a wealth of data and materials that were not available previously. Teachers who possess the necessary techno-pedagogical competency abilities can instruct their students on how to find, assess and use information from a variety of sources using technology. Since technology is very much pervasive now-a-days, students can acquire the abilities required to function well in a digital setting. Teachers can aid students in preparing for the job, where technology is used in a variety of tasks, by teaching them how to use it in the classroom. With the help of technology, students may connect and work with classmates and professionals from different parts of the world. Teachers who possess techno-pedagogical competency skills alone are able to design and facilitate global learning activities that advance cultural knowledge and understanding. Techno-pedagogical competency skills are essential for teachers to create a modern and engaging learning environment that prepares students for the challenges of the digital age.

In this context, it is felt by the researchers to conduct a study on examining the awareness of science teachers towards techno-pedagogical competency skills in secondary schools in relation to the demographic variables, viz., gender, location of the school and teaching experience. The present investigation is an attempt in this direction.

OBJECTIVES OF THE STUDY

The main objective of the present study is to explore the perceptions of teachers towards Techno-Pedagogical Competency skills in teaching science at secondary level.

The study also aims at finding out the influence of the demographic variables – gender, location of the school and teaching experience on the perceptions of teachers towards Techno-Pedagogical Competency skills in teaching science at secondary level.

HYPOTHESES OF THE STUDY

The following hypotheses have been formulated for the present investigation:

(i) There is no significant difference in the perceptions of male and female teachers towards Techno-Pedagogical Competency skills in teaching science at secondary level.

(ii) There is no significant difference in the perceptions of teachers working in rural and urban schools towards Techno-Pedagogical Competency skills in teaching science at secondary level.

(iii) There is no significant difference in the perceptions of teachers with an experience of less than 10 years and those with 10 years and above towards Techno-Pedagogical Competency skills in teaching science at secondary level.

LIMITATIONS OF THE STUDY

The study is limited to find out the influence of three demographic variables, viz., gender, location of the school and teaching experience on the perceptions of teachers towards Techno-Pedagogical

Competency skills in teaching science at secondary level.

DELIMITATIONS OF THE STUDY

The study is confined to explore the perceptions of 120 teachers (60 Headmasters and 60 School Assistants in Science) working in 60 selected secondary schools located in the rural as well as urban areas of Visakhapatnam District in Andhra Pradesh.

METHODOLOGY

(a) Method of Research

Since the present study involves collecting data with the help of a survey, the investigators used '**Descriptive survey' method** for the present investigation.

(b) Sample

A sample of 120 teachers (60 Headmasters and 60 School Assistants in Science) working in 60 selected secondary schools located in the rural as well as urban areas of Visakhapatnam District in Andhra Pradesh was selected using 'Stratified Random Sampling method'. In this method, in addition to randomness, stratification introduces a secondary element of control as a means of increasing precision and representativeness.

(c) .Research Tool

The researchers used a well-developed questionnaire consisting of 33 items as the tool of research for the present investigation under pilot study. The researchers have verified whether the tool prepared is in conformity with the conditions required by a standard tool, duly calculating the Reliability, Validity and Objectivity of the research tool.

(d) Administration of the Tool

The tool was initially administered to 20 teachers (10 Headmasters and 10 School Assistants in Science) working in 10 secondary schools in and around Visakhapatnam city under Pilot study. The measures of reliability, validity and objectivity of the tool have been calculated. Further, the researchers conducted item analysis for the items included in the tool. Out of 33 items selected for the tool, the discriminating power of 30 items has been found positive and is negative in respect of 3 items. The items whose discriminating power is negative have been removed; and the final tool consists of 30 items, which are pool proof in all respects. The final tool has been administered to 120 teachers (60 Headmasters and 60 School Assistants in Science) working in 60 selected secondary schools located in the rural as well as urban areas of Visakhapatnam District in Andhra Pradesh.

STATISTICAL INTERPRETATION OF DATA

The duly filled-in questionnaires have been collected from 120 respondents for purpose of tabulation of data.

The data collected has been analyzed and interpreted using different statistical techniques such as Mean scores, Standard Deviations and t-ratios; and are presented in the following table.

Table showing t-values of different variables relating to the perceptions of teachers towards Techno-Pedagogical Competency skills in teaching science at secondary level

S. No.	Variable		N	Mean	S. D.	t-ratio	Result
1	Gender	Male	50	103.30	22.98	0.31*	*Not Significant at 0.05 and 0.01 levels
		Female	70	101.93	25.81		
2	Location of the school	Rural	60	103.17	25.68	0.07*	*Not Significant at 0.05 and 0.01 levels
		Urban	60	102.83	25.06		

3	Teaching Experience	Less than 10 yrs 10 yrs. & above	80 40	92.75 107.00	22.47 25.05	3.04*	*Significant at 0.05 and 0.01 levels

FINDINGS OF THE STUDY

On the basis of the analysis and interpretation of data, the researchers have arrived at the following findings and drawn the conclusions.

1. There is no significant difference in the perceptions of male and female teachers towards Techno-Pedagogical Competency skills in teaching science at secondary level.
2. There is no significant difference in the perceptions of teachers working in rural and urban areas towards Techno-Pedagogical Competency skills in teaching science at secondary level.
3.
3. There is significant difference in the perceptions of teachers with an experience of less than 10 years and those with 10 years and above towards Techno-Pedagogical Competency skills in teaching science at secondary level.
   Teachers with an experience of 10 years and above perceived higher towards Techno-Pedagogical Competency skills in teaching science as compared to their junior counterparts with an experience of less than 10 years.

CONCLUSIONS

From the findings of the study, it is concluded that Gender and Location of the school have no influence on the perceptions of teachers towards Techno-Pedagogical Competency skills in teaching science at secondary level. However, 'Teaching Experience' has a significant positive influence on their perceptions towards Techno-Pedagogical Competency skills in teaching science, with senior teachers having an experience of 10 years and above perceiving higher toards Techno-Pedagogical Competency skills as compared to their junior counterparts with an experience of less than 10 years.

EDUCATIONAL IMPLICATIONS

(i) The study helps to motivate science teachers to improve their techno-pedagogical competency skills in their classroom teaching.

(ii) The present study makes science teachers realize the need for integration of technology in teaching science.

(iii) The study motivates teachers towards the use of digital tools in teaching science, avoiding the use of traditional and out-dated methods of teaching.

(iv) The study would bring awareness among teachers of science towards the advantages of using digital tools in teaching different concepts in science.

(v) The study would help the Academic Organizations like SCERTs, IASEs and the State Departments of Education to take necessary steps to organize Faculty Development Programmes (FDPs) periodically for the benefit of the science teachers in secondary schools in enhancing their Techno-Pedagogical Competency skills.

REFERENCES

Best, John W. and James V. Kahn (2003): *Research in Education.* New Delhi: Prentice Hall of India Private Limited.

Bhatia, K. K. (1974): *Measurement and Evaluation in Education*. Ludhiana: Prakash Brothers (Educational Publishers), 1974.

Garrett, H.E. (1965): *Statistics in Psychology and Education.* Bombay: Vakils, Feffer and Simons Private Limited, 3rd Indian Edition.

Good, C. V. (Ed.) (1945): *Dictionary of Education*. New York: McGraw Hill Book Company Inc.

Jai Prakash & Hooda, S. R. (2018): *A Study of techno-pedagogical competency among teachers of government and private schools of Haryana state*. International Journal of Current Advanced Research, Volume 7. DOI: http://dx.doi.org/10.24327/ijcar.2018.9306.1532

MHRD (2020): *Policy Document on 'National Education Policy-2020'.* New Delhi: Ministry of Human Resource Development, Government of India, July 29, 2020.

NCERT (2014): *Basics in Education*. Publications Division, National Council of Educational Research and Training (NCERT), Sri Aurobindo Marg, New Delhi, June, 2014. ISBN 978-93-5007-283-7

Pradeep Kumar, S.L. (2018): *A Study of Techno-Pedagogical skills of Secondary School Hindi teachers working in Kerala*. International Journal of Advance Research and Innovative Ideas in Education (IJARIIE), Volume 4, pp. 2395-2396.

Report of the Indian Education Commission (1964-66): *Education and National Development.* New Delhi: Ministry of Education, Government of India, 1966.

Saket Bihari (2025): *Exploring the Techno-Pedagogical Competency of Senior Secondary School Teachers*. Innovation Insights, Volume 1, May, 2025, pp.29-47.

Sidhu, Kulbir Singh (2002): *Methodology of Research in Education*. New Delhi: Sterling Publishers Private Limited.