Cover Page

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY EDUCATIONAL RESEARCH
ISSN:2277-7881(Print); IMPACT FACTOR :10.16(2026); IC VALUE:5.16; ISI VALUE:2.286
Peer-Peer Reviewed, Refereed & Open Access International Journal - As per UGC Norms
(Fulfilled Suggests Parameters of UGC by IJMER)
Volume:15, Issue:7(1), July 2026
Scopus Review ID: A2B96D3ACF3FEA2A
Article Received: Reviewed: Accepted
Publisher: Sucharitha Publication, India
Online Copy of Article Publication Available: www.ijmer.in

PEDAGOGICAL CONTENT KNOWLEDGE OF SCIENCE TEACHER WORKING IN GOVERNMENT SECONDARY SCHOOL OF BALASORE

[1]Banshidhar Sahu, [2]Prof. (Dr.) Jyoti Sankar Pradhan and [3]Dr. Satadal Giri
[1]Research Scholar, P.G. Department of Education, Fakir Mohan University, Vyasa Vihar, Balasore ,Odisha
[2]Professor of Education, P.G. Department of Education, Fakir Mohan University, Vyasa Vihar, Balasore, Odisha
[3]Assistant Professor, P.G. Department of Education, Fakir Mohan University, Vyasa Vihar, Balasore, Odisha.

Abstract

Pedagogical Content Knowledge (PCK) is recognized as a fundamental component of effective science teaching because it enables teachers to integrate subject matter knowledge with appropriate pedagogical strategies to facilitate meaningful student learning. The present study aimed to examine the level of Pedagogical Content Knowledge among science teachers working in government secondary schools in Balasore, Odisha, and to investigate whether significant differences existed with respect to gender, academic qualification, and teaching experience. A quantitative research approach employing a descriptive survey design was adopted. Data were collected from 50 science teachers selected through stratified random sampling using a researcher-developed Pedagogical Content Knowledge (PCK) Test comprising 40 multiple-choice items covering Physics, Chemistry, Biology, and Mathematics. The instrument was validated through expert review, and the collected data were analyzed using descriptive statistics (mean, median, standard deviation, and quartile deviation) and independent-samples *t*-tests at the 0.05 level of significance. The findings revealed that the participating science teachers possessed a consistently high level of Pedagogical Content Knowledge (M = 37.74, SD = 3.26). Furthermore, no statistically significant differences were observed in PCK with respect to gender, academic qualification, or teaching experience.

Keywords: Pedagogical Content Knowledge, Content Knowledge, Science Teachers, Government Secondary Schools, Science Education, Pedagogical Knowledge

I. INTRODUCTION

Pedagogical Content Knowledge (PCK) is well-established as one of the most significant teacher knowledge domains which is the knowledge that enables the teacher to make the content comprehensible to students. PCK was introduced by Shulman (1986) and has been expanded to include more than just knowledge of content and general pedagogical knowledge that focuses on how teachers can make the content meaningful in learning. PCK is crucial in science education due to the emphasis on abstract concepts, inquiry, and experimental tasks, helping to foster students' conceptual understanding, scientific reasoning, and problem-solving skills. High-quality science educators have to have a deep understanding of the science concepts and knowledge they are teaching, as well as the ability to recognize students' preconceived notions and determine the best methods of instruction, design an engaging learning environment, and use a variety of assessment strategies to support learning.

The multi-dimensionality of PCK and its important role in effective science teaching has been consistently emphasized in recent research. Research by Hasanah et al. (2024) showed that science teachers with a high level of curriculum knowledge, learner understanding, and instructional strategies, as well as good assessment competencies, had a well-developed PCK. Likewise, Timofte (2024) highlighted the influence of teachers' pedagogical orientation and scientific practices on the development of PCK, and Çaylak and Çakıroğlu (2024) noted that the pedagogical approaches of teachers teaching different types of learners are important in developing PCK in relation to the depth of content understanding. Additionally, She et al. (2024) found that teachers' PCK had a strong positive correlation with students' academic performance, suggesting that higher levels of teacher competence in teaching content lead to better learning outcomes. Mapulanga et al. (2024) and Muñoz-Galván and

Cover Page

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY EDUCATIONAL RESEARCH
ISSN:2277-7881(Print); IMPACT FACTOR :10.16(2026); IC VALUE:5.16; ISI VALUE:2.286
Peer-Peer Reviewed, Refereed & Open Access International Journal - As per UGC Norms
(Fulfilled Suggests Parameters of UGC by IJMER)
Volume:15, Issue:7(1), July 2026
Scopus Review ID: A2B96D3ACF3FEA2A
Article Received: Reviewed: Accepted
Publisher: Sucharitha Publication, India
Online Copy of Article Publication Available: www.ijmer.in

Padilla (2024) also found that curriculum integration, along with the integration of learner characteristics and SE, enhances science teacher instructional competence.

Research also indicates that teacher education and continuous professional development are also key factors in boosting PCK. Structured instructional interventions were found to have a significant positive impact on the content knowledge of preservice teachers in teaching (Van Orman et al., 2024), and practical teaching experiences were found to be key to the acquisition of PCK (Yanti et al., 2024). As noted by Almonacid-Fierro et al. (2023), PCK has been expanding to include the addition of technology and student thinking, which has been referred to as Technology Pedagogical Content Knowledge (TPACK), as pointed by Kasi et al. (2024). Likewise, Khan et al. (2023) highlighted the importance of pedagogical knowledge being coupled with content knowledge throughout teacher preparation programs to improve teaching quality.

A number of empirical studies have shown that teaching experience, professional learning and reflection play an important role in improving science teachers' PCK. The research conducted by Bayuo et al. (2022) and Usak et al. (2022) found that generally experienced science teachers have higher level of PCK than novices. Collaborative teacher learning communities significantly enhance understanding of the curriculum, planning, and assessment processes, according to Yang and Choi (2020). Similarly, Bertram (2017) and Hume (2010) showed that the implementation of Content Representations (CoRes) and Pedagogical and Professional-experience Repertoires (PaP-eRs) helps teachers be more reflective in their thinking, plan their lessons, and build sensitivity to the effective teaching strategies. Additionally, Halim et al. (2014) pointed out that students feel that teachers have a greater capability to meet their learning needs, and the teacher is able to make meaningful science learning, if the teacher has higher PCK.

Although there is a growing body of literature on pedagogical content knowledge (PCK) internationally, the empirical research on science teachers in government secondary schools in context of India is limited especially on district level. The character of curricular implementation, school facilities, access to teaching-learning materials, teacher training and professional development opportunities vary markedly from one educational context to another. Thus, having a knowledge of science teachers' pedagogical content knowledge in government secondary schools is critical for determining the strengths and areas that need development. The district of Balasore in Odisha is significant for studying these issues as government secondary schools still play an important role in imparting quality education in science to a large number of students. The aim of the present study is therefore to look into the pedagogical content knowledge of science teachers of government secondary schools of Balasore so that the study findings could support the enhancement of teacher education programmes, teacher professional development initiatives and science teaching practices in Balasore.

II. REVIEW OF RELATED LITERATURE

Hasanah et al., (2024). A study conducted on "Portrait of Pedagogical Content Knowledge (PCK) of Science Teachers in Global Islamic Boarding School Material Classification of Living Things". Hasanah et al. (2024) examined the PCK of science teachers in teaching the classification of living things. Using a qualitative descriptive approach, the study found that teachers demonstrated a balanced integration of content knowledge and pedagogical skills across multiple components, including curriculum knowledge, learner understanding, and assessment practices. This highlights the multidimensional nature of PCK in effective science teaching.

Yanti et al., (2024). A study conducted on "Analysis of Pedagogical Content Knowledge (PCK) Capabilities of Preservice Elementary School Teachers through Science Learning Planning". The study found that while participants demonstrated competence in selecting teaching methods, they exhibited limitations in content mastery and instructional material development. These findings suggest that practical teaching experience plays a vital role in strengthening PCK.

Cover Page

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY EDUCATIONAL RESEARCH
ISSN:2277-7881(Print); IMPACT FACTOR :10.16(2026); IC VALUE:5.16; ISI VALUE:2.286
Peer-Peer Reviewed, Refereed & Open Access International Journal - As per UGC Norms
(Fulfilled Suggests Parameters of UGC by IJMER)
Volume:15, Issue:7(1), July 2026
Scopus Review ID: A2B96D3ACF3FEA2A
Article Received: Reviewed: Accepted
Publisher: Sucharitha Publication, India
Online Copy of Article Publication Available: www.ijmer.in

Muñoz-Galván and Padilla (2024) conducted a study on "PCK in Teaching Sustainability Concepts." The objective was to analyze teachers' understanding of sustainability topics. A multiple case study design was used with 10 high school teachers. The findings highlighted that teachers' PCK significantly influenced their approach to environmental education.

Mapulanga et al. (2024) conducted a study on "Integration of Topic-Specific PCK in Biology Teaching." The objective was to examine how teachers integrate PCK components. A multiple case study design was used with three teachers. The findings indicated that teachers integrate multiple PCK components, especially curriculum and learner knowledge.

Almonacid-Fierro et al. (2023) conducted a systematic review on "PCK in Science Teacher Education." The objective was to analyze trends in PCK research. The study reviewed 13 selected articles. The findings highlighted the importance of integrating technology and student thinking into teaching practices.

Wang and Zhan (2023) conducted a literature review on "Static and Dynamic Perspectives of PCK." The objective was to examine PCK as a dynamic construct. The findings suggested that PCK evolves with teaching experience and context.

Khan et al. (2023) conducted a study on "Need Analysis of PCK in Prospective Teachers." The objective was to assess PCK needs. A mixed-method approach was used with survey and interviews. The findings highlighted the importance of integrating pedagogy with content knowledge.

Teachers Study (2022) examined PCK practices among 208 teachers using a descriptive-comparative design. The findings showed high levels of PCK, with variations based on experience and qualification.

Ramchand, (2022). A study conducted on "Pedagogic Content Knowledge of Science: A Framework for Practice and Construct for Understanding Teacher Preparation". This study aims to contribute towards an understanding of implementing curriculum reforms in teacher education in India, The findings highlighted the importance of PCK in improving conceptual understanding **Ramchand (2022)**.

Yanti and Suhandi (2020) conducted a study on "Assessment of Pedagogical Content Knowledge Using (CoRe)." The objective was to analyze teachers' PCK through the CoRe framework developed by Loughran. The study involved secondary school science teachers aged between 21 and 34 years. Data were collected through CoRe instruments. The findings revealed variations in teachers' PCK levels, which were influenced by teaching experience and professional development opportunities.

Yuliariatiningsih et al. (2019) conducted a study titled "Profile of Pedagogical Content Knowledge of Primary School Teachers in Science Teaching." The objective was to examine the level of PCK among primary school teachers. A survey method was used, and data were collected through interviews, questionnaires, tests, and observations. The findings revealed that teachers' PCK was significantly influenced by professional training programs, particularly teacher certification programs, while other demographic factors showed limited impact.

Purwianingsih and Mardiyah (2018) conducted a study on "Analysis of Pedagogical Content Knowledge in Planning and Reflecting on Environmental Pollution Content." The objective was to assess teachers' PCK using CoRe and PaP-eRs tools. A descriptive research design was adopted with a sample of six science teachers. The findings indicated that teachers demonstrated a moderate level of PCK. While lesson planning was relatively effective, discrepancies were observed in actual classroom implementation. Teaching experience and educational background were found to influence PCK.

Cover Page

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY EDUCATIONAL RESEARCH
ISSN:2277-7881(Print); IMPACT FACTOR :10.16(2026); IC VALUE:5.16; ISI VALUE:2.286
Peer-Peer Reviewed, Refereed & Open Access International Journal - As per UGC Norms
(Fulfilled Suggests Parameters of UGC by IJMER)
Volume:15, Issue:7(1), July 2026
Scopus Review ID: A2B96D3ACF3FEA2A
Article Received: Reviewed: Accepted
Publisher: Sucharitha Publication, India
Online Copy of Article Publication Available: www.ijmer.in

Bertram (2017) conducted a study titled "Enhancing Science Teachers' Knowledge of Practice through PCK Development." The objective was to examine the impact of explicit PCK development on teaching practices. The study used a pre-test and post-test design with six teachers over two years. CoRe and PaP-eRs tools were used as intervention strategies. The findings revealed that these tools significantly enhanced teachers' awareness of their teaching practices and promoted reflective thinking, leading to improved pedagogical effectiveness.

Halim et al. (2014) conducted a study on "Students' Perceptions of Their Science Teachers' Pedagogical Content Knowledge." The objective was to assess teachers' PCK from students' perspectives. A quantitative survey method was used with a sample of 316 secondary school students. Data were analyzed using ANOVA. The findings showed that students' perceptions of teachers' PCK varied significantly based on their academic achievement levels. The study emphasized that understanding students' learning needs is a crucial component of PCK.

Hume (2010) conducted a study titled "CoRes as Tools for Promoting Pedagogical Content Knowledge of Novice Science Teachers." The objective was to enhance PCK among preservice teachers using CoRe and PaP-eRs tools. A qualitative research design was adopted with a sample of eight preservice science teachers. Data were collected through workshops and instructional activities. The findings indicated that the use of CoRe significantly improved teachers' confidence, lesson planning ability, and understanding of key PCK components.

III. RATIONALE OF THE STUDY

The increasing emphasis on effective science teaching has brought Pedagogical Content Knowledge (PCK) to the forefront of science education research. Numerous studies have highlighted the pivotal role PCK plays in improving teaching practices, enhancing student understanding, and addressing contemporary challenges in science education. Despite a growing body of literature, gaps remain in understanding how PCK develops across different educational contexts, how it can be effectively assessed, and how it impacts student outcomes. Research indicates that both in-service and pre-service teachers often face difficulties in integrating content knowledge with pedagogy, especially when designing lessons or addressing students' misconceptions (Yanti et al., 2024; Mapulanga et al., 2024). Other studies have identified that teachers' development of PCK is influenced by factors such as teaching experience, professional training, and the specific needs of learners, including gifted students (Çaylak & Çakıroğlu, 2024; Bayuo et al., 2022). Moreover, there is an increasing focus on topic-specific PCK (TSPCK) and its application in planning and reflecting on science lessons (Mavhunga & Ndlovu, 2023; Purwianingsih & Mardiyah, 2018). Another significant trend is the incorporation of assessment tools like CoRe and PaP-eRs to evaluate and promote PCK development among science teachers (Bertram, 2017; Hume, 2010). Studies also suggest that the mode of PCK assessment—whether text-based or video-based—can influence the accuracy of PCK evaluation and its correlation with student achievement (She et al., 2024; She & Chan, 2022). Furthermore, the integration of technology in teaching (TPACK) and the relevance of PCK in addressing socio-scientific issues like sustainability and environmental pollution have added new dimensions to PCK research (Kasi et al., 2024; Muñoz-Galván & Padilla, 2024).

Although there is a vast amount of international literature available, the present scenario is quite deficient in empirical research on pedagogical content knowledge of in-service science teachers in government secondary schools in the Indian context in particular in Odisha. The majority of the research conducted in India has focused on teacher education programs or preservice teacher preparation than on practicing secondary school teachers. Moreover, there has been no such detailed study that has specifically studied the level of PCK possessed by science teachers of the Government Secondary Schools of Balasore district. In the backdrop of the changes in the education system being brought about by the National Education Policy (NEP) 2020 and the shift towards competency-based education, experiential pedagogy, and inquiry-based science education, it is now more important than ever to determine if science teachers have the pedagogical skills needed to successfully implement science reforms.

Cover Page

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY EDUCATIONAL RESEARCH
ISSN:2277-7881(Print); IMPACT FACTOR :10.16(2026); IC VALUE:5.16; ISI VALUE:2.286
Peer-Peer Reviewed, Refereed & Open Access International Journal - As per UGC Norms
(Fulfilled Suggests Parameters of UGC by IJMER)
Volume:15, Issue:7(1), July 2026
Scopus Review ID: A2B96D3ACF3FEA2A
Article Received: Reviewed: Accepted
Publisher: Sucharitha Publication, India
Online Copy of Article Publication Available: www.ijmer.in

The government Secondary schools of Balasore serve students from various socio-economic and educational backgrounds. Science teachers in these schools are required not only to have a sound knowledge of the subject but also to use appropriate pedagogy with emphasis on scientific enquiry, concepts, critical thinking, problem-solving etc. It will be beneficial to know the existing level of Pedagogical Content Knowledge for teachers to determine strengths and the need for professional support. The outcomes of such a study may well serve as inputs in making need based in-service programme and enhancing the science teacher education of science teachers by education planners, school administrators, teacher educators, SCERT Odisha and other professional development agencies.

Hence, the present study, "Pedagogical Content Knowledge of Science Teachers in Government Secondary Schools of Balasore" has been undertaken to find out the existing picture of the level of pedagogical content knowledge of science teachers and to provide empirical evidence that contributes to the improvement of science education in government secondary schools.

IV. OPERATIONAL DEFINITION OF THE KEY TERMS USED

Pedagogical Content Knowledge (PCK): Pedagogical Content Knowledge (PCK) refers to the science teacher's integrated understanding of subject matter knowledge and pedagogical strategies used to teach that content effectively. It includes knowledge of: Students' prior understanding and misconceptions, Appropriate instructional strategies, Assessment methods, and Curriculum knowledge specific to science topics.

Science Teacher: A science teacher in this study refers to a professionally trained individual (either pre-service or in-service) responsible for teaching science subjects such as Physics, Chemistry, Biology, or General Science at the elementary, secondary, or higher secondary school level.

Content Knowledge: Content knowledge is defined as the teacher's mastery of the subject matter in science, including facts, concepts, theories, and principles relevant to the curriculum.

Pedagogical Knowledge: Pedagogical knowledge includes the general methods and strategies of teaching that are not subject-specific, such as classroom management, instructional planning, and understanding of learners' needs.

V. OBJECTIVE OF THE STUDY

To Study the level of pedagogical content knowledge of government secondary school Science teacher at Balasore.

To Study the pedagogical content knowledge of government secondary school Science teacher with reference to the gender.

To Study the pedagogical content knowledge of government secondary school Science teacher with difference to qualification

To Study the pedagogical content knowledge of government secondary school Science teacher with difference to the experiences.

VI. HYPOTHESIS OF THE STUDY

There is no significant difference in the level of Pedagogical Content Knowledge (PCK) of secondary school science teachers with respect to gender.

There is no significant difference in the level of Pedagogical Content Knowledge (PCK) of secondary school science teachers with respect to qualification.

Cover Page

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY EDUCATIONAL RESEARCH
ISSN:2277-7881(Print); IMPACT FACTOR :10.16(2026); IC VALUE:5.16; ISI VALUE:2.286
Peer-Peer Reviewed, Refereed & Open Access International Journal - As per UGC Norms
(Fulfilled Suggests Parameters of UGC by IJMER)
Volume:15, Issue:7(1), July 2026
Scopus Review ID: A2B96D3ACF3FEA2A
Article Received: Reviewed: Accepted
Publisher: Sucharitha Publication, India
Online Copy of Article Publication Available: www.ijmer.in

There is no significant difference in the level of Pedagogical Content Knowledge (PCK) of secondary school science teachers with respect to experiences.

DELIMITATION OF THE STUDY

- ✓ The present study was delimited to science teachers working in selected government secondary schools in Balasore, Odisha.
- ✓ It was delimited to only teachers responsible for teaching science subjects at the secondary level.
- ✓ The study was delimited to only male and female teachers comprising 50 participants only.

VII. METHODOLOGY

The present study adopted a quantitative research approach using a descriptive survey design to examine the Pedagogical Content Knowledge (PCK) of science teachers working in government secondary schools in Balasore, Odisha. This design was considered appropriate because it facilitates the systematic collection and analysis of data for describing existing educational phenomena and examining group differences without manipulating the study variables. The target population comprised science teachers employed in government secondary schools in Balasore town, from which a sample of 50 teachers was selected through stratified random sampling to ensure representation across gender, academic qualification, and teaching experience. Data were collected using a researcher-developed Pedagogical Content Knowledge (PCK) Test consisting of 40 multiple-choice items distributed equally across four science curriculum domains—Physics, Chemistry, Biology, and Mathematics—with each correct response carrying one mark, yielding a maximum score of 40. The instrument was developed in accordance with the secondary school curriculum (Classes IX–X) to assess teachers' knowledge of instructional strategies, learner misconceptions, curriculum implementation, assessment practices, and content-specific pedagogy. To establish content validity, the instrument was reviewed by experienced science educators, teacher educators, and subject experts, and necessary revisions were incorporated based on their recommendations. Prior to data collection, permission was obtained from the respective school authorities, and informed consent was secured from all participants. Participation was voluntary, and confidentiality and anonymity were maintained throughout the study. Data were collected using both online and offline modes, including Google Forms and printed questionnaires administered personally by the researcher to ensure a high response rate and completeness of responses. The collected data were coded and analyzed using descriptive and inferential statistical techniques. Descriptive statistics, including mean, median, standard deviation, and quartile deviation, were employed to determine the overall level and distribution of teachers' Pedagogical Content Knowledge, while independent-samples *t*-tests were conducted to examine differences in PCK with respect to gender, academic qualification, and teaching experience at the 0.05 level of significance. The findings were interpreted in accordance with the study objectives while adhering to accepted ethical standards for educational research.

VIII. DATA ANALYSIS AND INTERPRETATION

PEDAGOGICAL CONTENT KNOWLEDGE OF SCIENCE TEACHERS

The first objective of this research was to find out the Pedagogical Content Knowledge of science teachers. Descriptive statistics were used to understand the overall level and distribution of Pedagogical Content Knowledge (PCK) among government secondary school science teachers at Balasore. The Mean, Standard Deviation (SD), and Quarter Deviation (QD) were calculated. The table-1 presents the mean, standard deviation, and quarter deviation of the PCK Score of teachers having different level of pedagogical content knowledge.

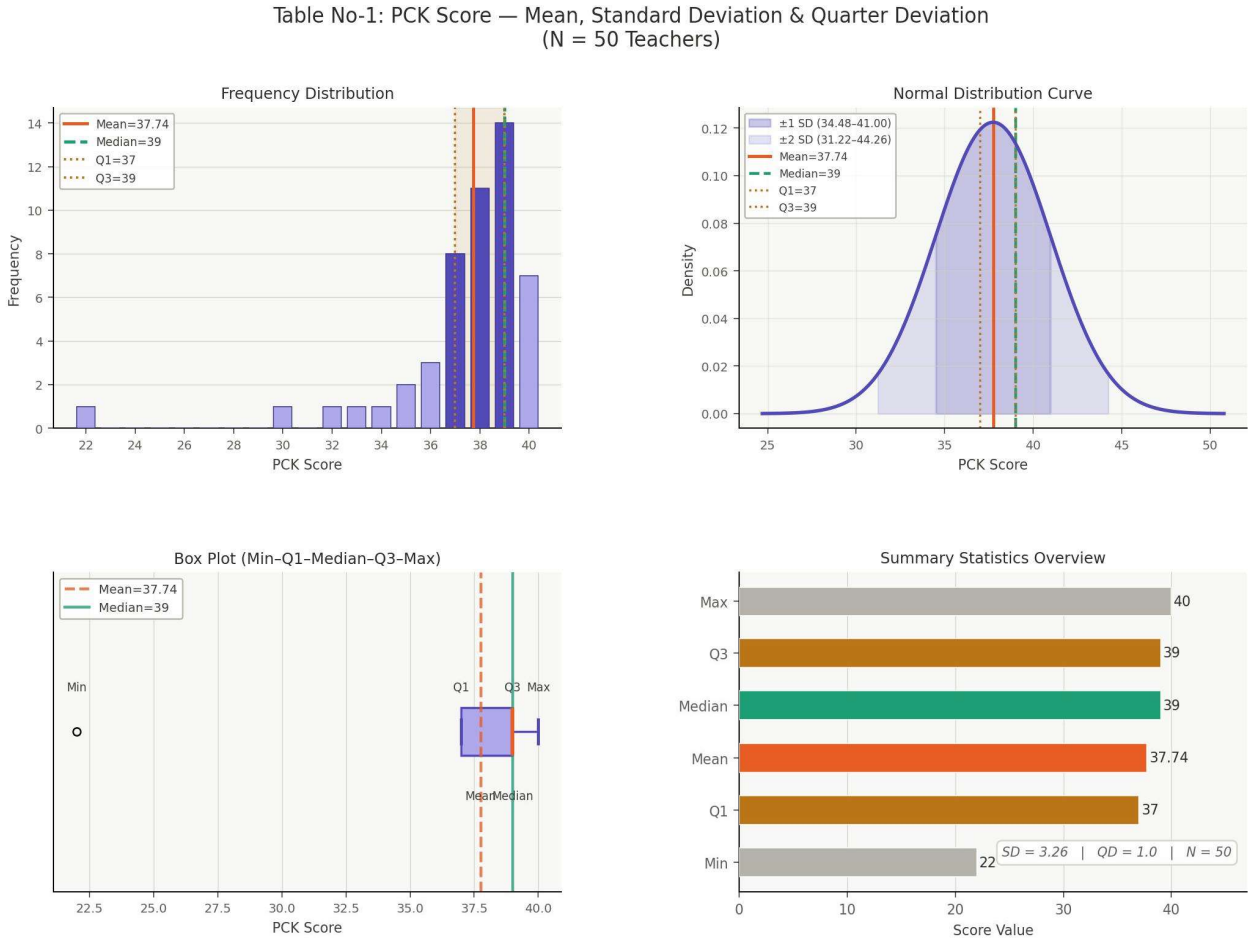
Cover Page

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY EDUCATIONAL RESEARCH
ISSN:2277-7881(Print); IMPACT FACTOR :10.16(2026); IC VALUE:5.16; ISI VALUE:2.286
Peer-Peer Reviewed, Refereed & Open Access International Journal - As per UGC Norms
(Fulfilled Suggests Parameters of UGC by IJMER)
Volume:15, Issue:7(1), July 2026
Scopus Review ID: A2B96D3ACF3FEA2A
Article Received: Reviewed: Accepted
Publisher: Sucharitha Publication, India
Online Copy of Article Publication Available: www.ijmer.in

Table-1: Mean, standard deviation, and quarter deviation of the PCK score of teachers having different level of pedagogical content knowledge.

Variable	N	Min	Max	Mean	Median	SD	Q1	Q3	QD
PCK Score	50	22	40	37.74	39	3.26	37	39	1

The table.1 shows that the Mean score (37.74 out of 40) indicates a very high level of Pedagogical Content Knowledge among science teachers. The Standard Deviation (3.23) shows that the variation in scores is low. The Quarter Deviation (1) further confirms that the middle 50% of teachers' scores are closely clustered between 37 and 39. The dispersion is very low, This indicates that most teachers possess consistently high PCK levels.



(Fig1: Shows teachers having different level of Pedagogical Content Knowledge)

Cover Page

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY EDUCATIONAL RESEARCH
ISSN:2277-7881(Print); IMPACT FACTOR :10.16(2026); IC VALUE:5.16; ISI VALUE:2.286
Peer-Peer Reviewed, Refereed & Open Access International Journal - As per UGC Norms
(Fulfilled Suggests Parameters of UGC by IJMER)
Volume:15, Issue:7(1), July 2026
Scopus Review ID: A2B96D3ACF3FEA2A
Article Received: Reviewed: Accepted
Publisher: Sucharitha Publication, India
Online Copy of Article Publication Available: www.ijmer.in

PEDAGOGICAL CONTENT KNOWLEDGE OF MALE AND FEMALE SCIENCE TEACHERS

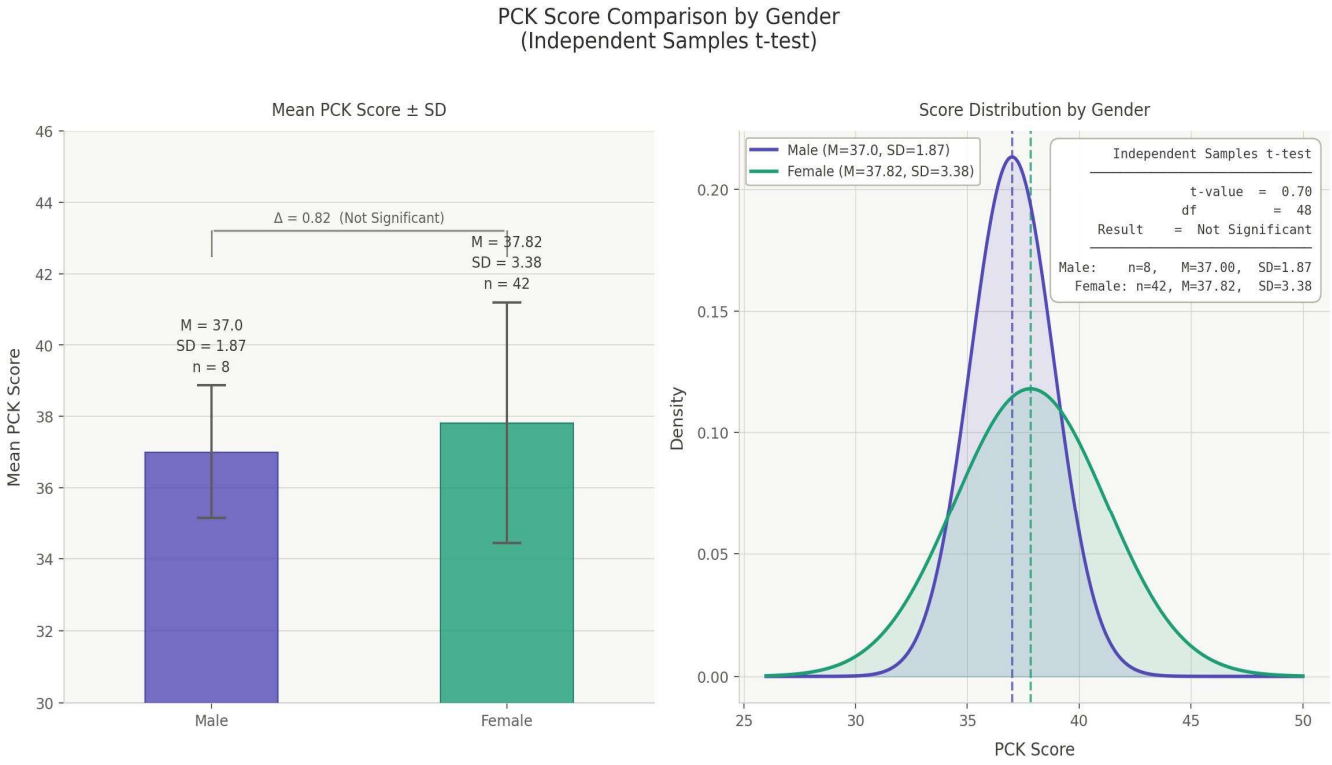
The second objective was to compare the **Pedagogical Content Knowledge** of male and female science teachers. For this, researcher calculated t-value which is presented in table no - 2.

Table-2: t-value of Pedagogical Content Knowledge of Male and Female Science Teachers

Gender	N	Mean	SD	t-test	df	Result
Male	8	37.00	1.87	0.70	48	Not Significant
Female	42	37.82	3.38			

The table 2 shows that the computed t-value (0.70) is smaller than the table value (2.01). So, null hypothesis is accepted. The findings suggest that male and female science teachers do not differ significantly in their pedagogical content knowledge. Female teachers have slightly higher mean (37.82) compared to male teachers (37.00). However, both groups show high PCK levels. The SD for males (1.87) is lower, indicating more consistency among male teachers. The SD for females (3.38) shows slightly more variation, but still within a small range. Overall, both male and female teachers demonstrate strong pedagogical competence. The mean difference is presented graphically in the Fig. 2

(Fig 2: Bar chart (left) showing Mean ± SD and distribution curves (right) for Male and Female PCK scores)



Cover Page

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY EDUCATIONAL RESEARCH
ISSN:2277-7881(Print); IMPACT FACTOR :10.16(2026); IC VALUE:5.16; ISI VALUE:2.286
Peer-Peer Reviewed, Refereed & Open Access International Journal - As per UGC Norms
(Fulfilled Suggests Parameters of UGC by IJMER)
Volume:15, Issue:7(1), July 2026
Scopus Review ID: A2B96D3ACF3FEA2A
Article Received: Reviewed: Accepted
Publisher: Sucharitha Publication, India
Online Copy of Article Publication Available: www.ijmer.in

PEDAGOGICAL CONTENT KNOWLEDGE OF SCIENCE TEACHERS IN RELATION TO THEIR QUALIFICATION

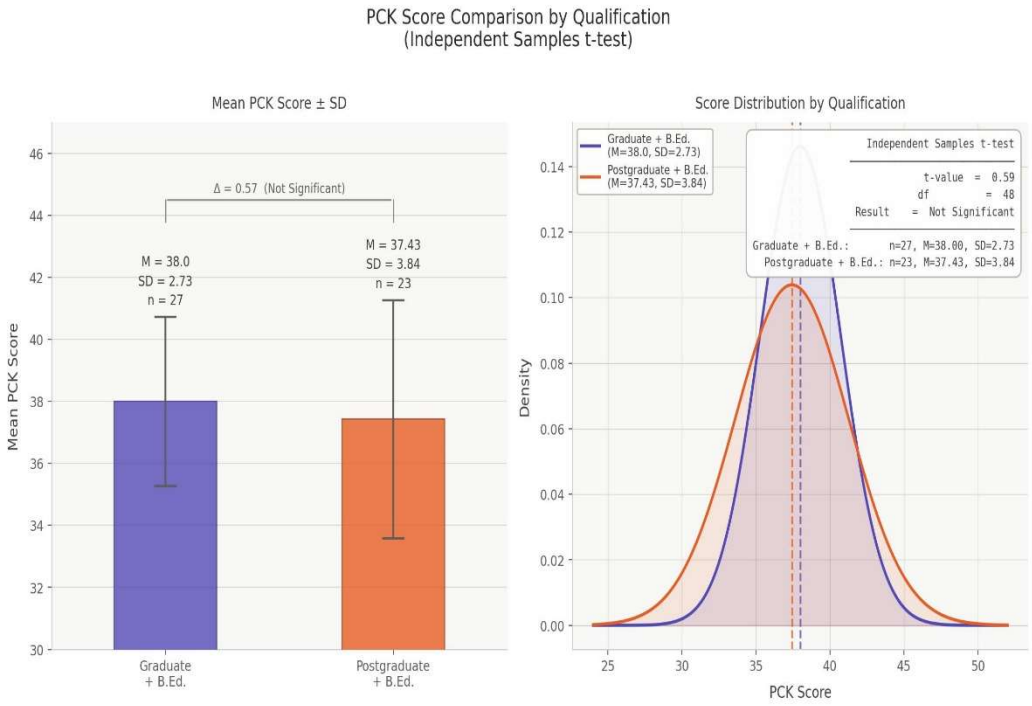
The third objective was to compare the Pedagogical Content Knowledge of science teachers having different qualification i.e. Graduate with B.Ed. and Postgraduate with B.Ed., The calculated t-value by the researcher is shown in the table-3

Table-3: t-value of Pedagogical Content Knowledge of Science Teachers having Different Qualification

Qualification	N	Mean	SD	t-value	df	Result
Graduate with B.Ed.	27	38.00	2.73	0.59	48	Not Significant
Postgraduate with B.Ed.	23	37.43	3.84			

Table-3 signifies that the obtained t-value (0.59) is smaller than the table value (2.01). So, null hypotheses are accepted. The findings indicate that teachers holding Graduate with B.Ed. and Postgraduate with B.Ed. qualifications do not differ significantly in their pedagogical content knowledge. Postgraduate teachers have a slightly lower mean (37.43) than graduates (38.00). However, the difference is very small. The SD for graduates (2.73) shows slightly more variability. Postgraduates (SD = 3.84) show more uniform performance. Qualification does not create a large difference in PCK level. The difference in mean value is graphically presented in the Fig 3

(Fig 3: Bar chart (left) showing Mean ± SD and distribution curves (right) for Graduate + B.Ed. and Postgraduate + B.Ed. PCK scores)



Cover Page

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY EDUCATIONAL RESEARCH
ISSN:2277-7881(Print); IMPACT FACTOR :10.16(2026); IC VALUE:5.16; ISI VALUE:2.286
Peer-Peer Reviewed, Refereed & Open Access International Journal - As per UGC Norms
(Fulfilled Suggests Parameters of UGC by IJMER)
Volume:15, Issue:7(1), July 2026
Scopus Review ID: A2B96D3ACF3FEA2A
Article Received: Reviewed: Accepted
Publisher: Sucharitha Publication, India
Online Copy of Article Publication Available: www.ijmer.in

PEDAGOGICAL CONTENT KNOWLEDGE OF SCIENCE TEACHERS HAVING DIFFERENT LENGTH OF EXPERIENCES

The fourth objective was to compare the Pedagogical Content Knowledge of science teachers in relation to their experience. The researcher grouped the sample into two categories such as teachers having- below 10 years' experience, and above 10 years' experience, The Table-4 presents t-value of teachers having below 10 years' experience, and above 10 years' experience

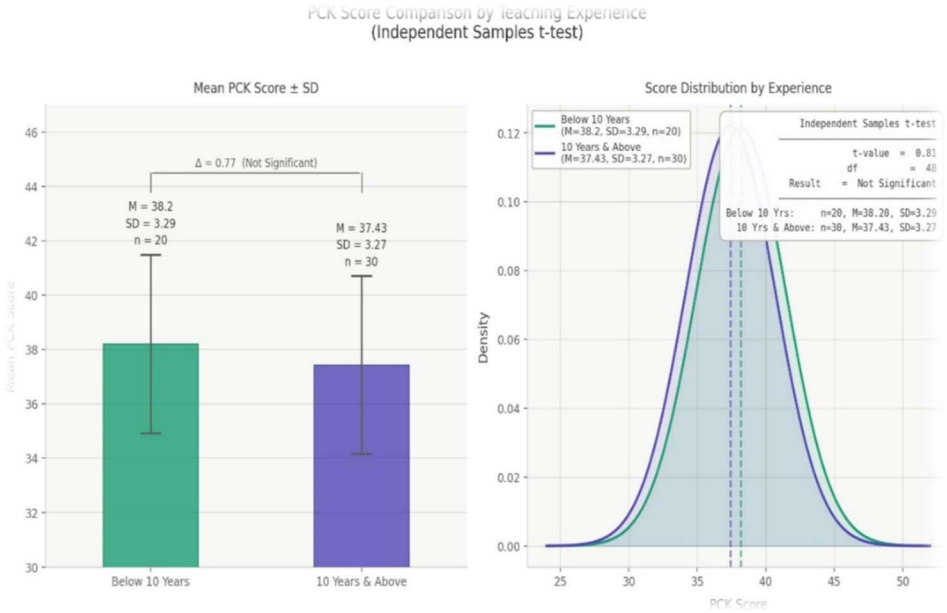
Table-4: t-value of below 10 years and above 10 years having Different Length of Experience

Experience	N	Mean	SD	t- value	df	Result
Below 10 Years	20	38.20	3.29	0.81	48	Not Significant
10 Years & Above	30	37.43	3.27			

The table 4; revealed that calculated t-value (0.81) of Below 10 Years, 10 Years & Above is smaller than the table value (2.01). So, null hypotheses are accepted. The findings indicate no statistically significant difference in pedagogical content knowledge between teachers with less than 10 years and those with 10 years or more experience. Teachers with less than 10 years of experience have a slightly higher mean (38.20). Teachers with more than 10 years have mean 37.43. The SD values are almost equal, indicating similar variation in both groups. Teaching experience does not show a major difference in PCK level. The difference in mean value graphically presented in the Fig 4.

(Fig 4 -Bar chart (left) showing Mean ± SD and distribution curves (right) for Below 10 Years and 10 Years & Above PCK scores)

IX. MAJOR FINDINGS



Cover Page

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY EDUCATIONAL RESEARCH
ISSN:2277-7881(Print); IMPACT FACTOR :10.16(2026); IC VALUE:5.16; ISI VALUE:2.286
Peer-Peer Reviewed, Refereed & Open Access International Journal - As per UGC Norms
(Fulfilled Suggests Parameters of UGC by IJMER)
Volume:15, Issue:7(1), July 2026
Scopus Review ID: A2B96D3ACF3FEA2A
Article Received: Reviewed: Accepted
Publisher: Sucharitha Publication, India
Online Copy of Article Publication Available: www.ijmer.in

1 The study revealed that science teachers working in government secondary schools in Balasore demonstrated a consistently high level of Pedagogical Content Knowledge (PCK), indicating their ability to integrate subject matter knowledge with appropriate pedagogical practices for effective science teaching.
2 The participating science teachers possessed a consistently high level of Pedagogical Content Knowledge (M = 37.74, SD = 3.26).
3 Furthermore, no statistically significant differences were observed in PCK with respect to gender, academic qualification, or teaching experience.
4 The analysis further showed that there was no statistically significant difference in teachers' PCK with respect to gender, suggesting that both male and female science teachers possessed comparable pedagogical competence.
5 Similarly, academic qualification did not significantly influence teachers' PCK, indicating that higher academic degrees alone were not associated with superior pedagogical content knowledge.
6 Overall, the findings suggest that science teachers in the selected government secondary schools possess relatively uniform levels of Pedagogical Content Knowledge irrespective of demographic characteristics, highlighting the importance of sustained professional development to further strengthen effective science teaching.

X. DISCUSSION

The objective of the present study was to investigate secondary school science teachers' pedagogical content knowledge (PCK) and to find if there are significant differences in PCK between various groups of secondary science teachers with respect to gender, academic qualification and teaching experience. Results show that the teachers participating in the study have a very high level of PCK and that gender, qualification and teaching experience do not have significant impacts on their PCK.

The overall mean score for Pedagogical Content Knowledge (PCK) of the secondary school science teachers in the present study is 37.74 out of 40, hence a very high score, which means that majority of the science teachers integrate subject matter knowledge with appropriate pedagogical strategies and are effective in facilitating meaningful science learning. This result aligns with the research findings of Almonacid-Fierro et al. (2023), Hasanah et al. (2024), and the Public-School Science Teachers Study (2022) which found that a good PCK helps teachers incorporate curriculum knowledge, learner understanding, instructional strategies, assessment practices, and technology into effective science instruction. Likewise, She et al., (2024) determined that teachers' PCK had a positive effect on the learning achievements of their students, and that pedagogical competency plays a very important role in improving learning achievements. The high PCK in the present study can be explained by the constant changes in curriculum, professional development and the increased focus on learner-centred and competency-based science education.

The study also revealed that there were no statistically significant differences between the pedagogical content knowledge of teachers based on gender and qualifications. Male and female science teachers exhibited similar levels of PCK, indicating that pedagogical competence is more influenced by professional learning and classroom practices, rather than demographic variables. The result is consistent with the study of Yuliariatiningsih et al. (2019) and Hasanah et al. (2024) which found that professional development has a higher influence on PCK than gender. Similarly, there was no significant difference between the teachers with graduate and post graduate qualifications, implying that the pedagogical competence is not necessarily improved as a result of higher academic qualifications. The findings align with Bayuo et al. (2022), Khan et al. (2023), and Yang and Choi (2020) who stressed that reflective practice, collaborative learning, and continuous professional development are more significant than formal academic qualifications in enhancing teachers' PCK.

The other important results of the study are that science teachers' pedagogical content knowledge was not significantly affected by the teaching experience. The teachers with less than ten years of teaching experience showed a level of PCK that was similar to those with more years of teaching experience indicating that PCK is a

Cover Page

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY EDUCATIONAL RESEARCH
ISSN:2277-7881(Print); IMPACT FACTOR :10.16(2026); IC VALUE:5.16; ISI VALUE:2.286
Peer-Peer Reviewed, Refereed & Open Access International Journal - As per UGC Norms
(Fulfilled Suggests Parameters of UGC by IJMER)
Volume:15, Issue:7(1), July 2026
Scopus Review ID: A2B96D3ACF3FEA2A
Article Received: Reviewed: Accepted
Publisher: Sucharitha Publication, India
Online Copy of Article Publication Available: www.ijmer.in

continuous practice that can be developed through reflective practice, professional learning, and institutional support rather than just years of service. This result is partly in line with the results of the research conducted by Wang and Zhan (2023) and Usak et al. (2022) who found that there was a positive effect of teaching experience on the development of PCK. This is not the same with the research conducted by Bayuo et al. (2022), Yanti and Suhandi (2020), and Purwianingsih and Mardiyah (2018) who found positive relationship between teaching experience and PCK. The variations observed might be explained by the similarities in teacher training programs, continuing professional development, and recent reforms in education that have reduced differences in pedagogical expertise among teachers with different levels of experience. The results generally suggest that, regardless of the gender, academic qualifications or years of experience, science teachers have a good pedagogical content knowledge which underlines the need for continuous professional development and reflective practice to respond to the changing demands of science education.

XI. CONCLUSION

This study examined the Pedagogical Content Knowledge (PCK) of science teachers working in government secondary schools in Balasore, Odisha, and investigated whether significant differences existed with respect to gender, academic qualification, and teaching experience. The findings indicate that the participating teachers possessed a consistently high level of Pedagogical Content Knowledge, reflecting their ability to integrate subject matter expertise with appropriate pedagogical practices for effective science teaching. Furthermore, no statistically significant differences were observed in PCK across gender, academic qualification, or teaching experience, suggesting that pedagogical competence was relatively consistent among the sampled teachers regardless of these demographic characteristics. These findings reinforce the view that effective teaching depends not merely on academic credentials or years of experience but on the continuous development of pedagogical expertise through professional learning and reflective practice. The study contributes to the existing literature by providing empirical evidence from government secondary schools in an under-researched regional context of Odisha, thereby addressing an important gap in science teacher education research. The findings have practical implications for teacher education institutions, school administrators, and policymakers by highlighting the need to strengthen continuous professional development programmes that promote topic-specific pedagogy, inquiry-based teaching, formative assessment, and technology-integrated instructional practices. Future research should employ larger and more diverse samples across different geographical regions and educational settings and adopt mixed-methods or longitudinal designs to obtain a more comprehensive understanding of the factors influencing the development of Pedagogical Content Knowledge among science teachers.

REFERENCES

1. Almonacid-Fierro, A., Sepúlveda-Vallejos, S., Valdebenito, K., Montoya-Grisales, N. E., & Aguilar-Valdés, M. (2023). Analysis of Pedagogical Content Knowledge in Science Teacher Education: A Systematic Review 2011-2021. International Journal of Educational Methodology. https://doi.org/10.12973/ijem.9.3.525
2. Bayuo, J., Abukari, M. A., Alagbela, A. A., & Bornaa, C. S. (2022). Pedagogical Content Knowledge of Science Tutors and Its Influence on Their Trainees. Contemporary Mathematics and Science Education, 3(1), ep22008. https://doi.org/10.30935/conmaths/1183037
3. Bertram, A. R. (2017). Enhancing science teachers' knowledge of practice by explicitly developing pedagogical content knowledge. https://doi.org/10.4225/03/587837D55FDFF
4. Cadiz, A. P. (2024). Development and Validation of a Test Instrument in Assessing the Content Knowledge of Grade 3 Teachers in Science. The Quest, 3(1). https://doi.org/10.60008/thequest.v3i1.199
5. Çaylak, B., & Çakıroğlu, J. (2024). Construction of a Science Teacher's Topic-Specific Pedagogical Content Knowledge in the Gifted Class. E- Kafkas Eğitim Araştırmaları Dergisi, 11(3), 378–401. https://doi.org/10.30900/kafkasegt.1491730

Cover Page

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY EDUCATIONAL RESEARCH
ISSN:2277-7881(Print); IMPACT FACTOR :10.16(2026); IC VALUE:5.16; ISI VALUE:2.286
Peer-Peer Reviewed, Refereed & Open Access International Journal - As per UGC Norms
(Fulfilled Suggests Parameters of UGC by IJMER)
Volume:15, Issue:7(1), July 2026
Scopus Review ID: A2B96D3ACF3FEA2A
Article Received: Reviewed: Accepted
Publisher: Sucharitha Publication, India
Online Copy of Article Publication Available: www.ijmer.in

6. Fitriyah, L. A., Hayati, N., & Wijayadi, A. W. (2020). The content knowledge ability of science teacher candidates: the analysis of learning media development. 7(2), 83–87. https://doi.org/10.21107/JPS.V7I2.7995
7. Halim, L., Syed Abdullah, S. I. S., & Mohd Meerah, T. S. (2014). Students' Perceptions of Their Science Teachers' Pedagogical Content Knowledge. Journal of Science Education and Technology, 23(2), 227–237. https://doi.org/10.1007/S10956-013-9484-2
8. Hasanah, P., Fahmi, F., Irhasyuarna, Y., & Putri, R. F. (2024). Portrait of Pedagogical Content Knowledge (PCK) of Science Teachers in Global Islamic Boarding School Material Classification of Living Things. Jurnal Penelitian Pendidikan IPA (JPPIPA), 10(7), 3827–3837. https://doi.org/10.29303/jppipa.v10i7.7617
9. Hume, A. (2010). CoRes as tools for promoting pedagogical content knowledge of novice science teachers. 119, 13–19. https://researchcommons.waikato.ac.nz/bitstream/handle/10289/7405/ChemEdNZ_Apr10_Hume.pdf?sequence=1
10. Kasi, Y. F., Widodo, A., Samsudin, A., Riandi, R., Sola, G. Y., & Pao, B. (2024). The Birth, Growth, and Development of Pedagogical Content Knowledge (Pck). KnE Social Sciences, 9(19), 433–447. https://doi.org/10.18502/kss.v9i19.16532
11. Kesavadev, J. (2022). Science Teachers' Pedagogical Content Knowledge of Plastic Waste. https://doi.org/10.26756/th.2022.457
12. Khan, S., Mumtaz, R., & Batool, S. (2023). Need Analysis of Prospective Science Teachers about Pedagogical Content Knowledge through Learning Activities. Journal of Research in Social Sciences, 11(2), 37–59. https://doi.org/10.52015/jrss.11i2.180
13. Mapulanga, T., Ameyaw, Y., Nshogoza, G., & Bwalya, A. (2024). Integration of topic-specific pedagogical content knowledge components in secondary school science teachers' reflections on biology lessons. Discover Education. https://doi.org/10.1007/s44217-024-00104-y
14. Mavhunga, E., & Ndlovu, B. P. (2023). Defining Science Content Knowledge for Teaching as a Base for Teacher Development: A Case for Organic Chemistry. African Journal of Research in Mathematics, Science and Technology Education, 27(2), 97–111. https://doi.org/10.1080/18117295.2023.2247711
15. Muñoz-Galván, M., Padilla, K. Pedagogical content knowledge about the sustainability of high school chemistry and biology teachers. J Environ Stud Sci 14, 652–665 (2024). https://doi.org/10.1007/s13412-024-00919-z
16. Pedagogical Content Knowledge Practices of Public School Science Teachers. (2022). Technium Social Sciences Journal, 37, 37–50. https://doi.org/10.47577/tssj.v37i1.7584
17. Purwianingsih, W., & Mardiyah, A. (2018). Analysis of pedagogical content knowledge (PCK) ability of science teachers in planning and reflecting on environmental pollution content. 1013(1), 012076. https://doi.org/10.1088/1742-6596/1013/1/012076
18. Ramchand, M. (2022). Pedagogic Content Knowledge of Science: A Framework for Practice and Construct for Understanding Teacher Preparation. Contemporary Education Dialogue, 19(2), 281–303. https://doi.org/10.1177/09731849221083063
19. She, J., & Chan, K. K. H. (2022). Situated and dynamic versus declarative and static forms of pedagogical content knowledge: An evaluation of the differences in test reactions and performance. Journal of Research in Science Teaching, 60(3), 568–607. https://doi.org/10.1002/tea.21810
20. She, J., Chan, K. K. H., Wang, L., Hu, X., & Liu, E. (2024). Effect of Science Teachers' Pedagogical Content Knowledge on Student Achievement: Evidence From Both Text- 36 and Video-Based Pedagogical Content Knowledge Tests. American Educational Research Journal. https://doi.org/10.3102/00028312241278627
21. Timofte, R. S. (2024). Developing pedagogical content knowledge by teachers in the context of engaging students in scientific practices. Akademos: Revista de Ştiinţă, Inovare, Cultură Şi Artă, 3(74), 149–154. https://doi.org/10.52673/18570461.24.3-74.16
22. Usak, M., Uygun, H., & Duran, M. (2022). The effects of science teachers' pedagogical content knowledge on students' attitudes toward science and their achievement. Journal of Baltic Science Education, 21(4), 694–705. https://doi.org/10.33225/jbse/22.21.694

Cover Page

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY EDUCATIONAL RESEARCH
ISSN:2277-7881(Print); IMPACT FACTOR :10.16(2026); IC VALUE:5.16; ISI VALUE:2.286
Peer-Peer Reviewed, Refereed & Open Access International Journal - As per UGC Norms
(Fulfilled Suggests Parameters of UGC by IJMER)
Volume:15, Issue:7(1), July 2026
Scopus Review ID: A2B96D3ACF3FEA2A
Article Received: Reviewed: Accepted
Publisher: Sucharitha Publication, India
Online Copy of Article Publication Available: www.ijmer.in

23. Van Orman, D., Melton, J., Hanley, D., Castellano, K. E., Mikeska, J. N., Hanuscin, D. L., & Borda, E. (2024). Supporting elementary preservice teachers' content knowledge for teaching about matter and its interactions. Journal of Research in Science Teaching. https://doi.org/10.1002/tea.21994
24. Wang, L., & Zhan, F. (2023). Elaborating Teachers' Pedagogical Content Knowledge from Static and Dynamic Perspectives. Creative Education, 14, 2301-2312. https://doi.org/10.4236/ce.2023.1411145
25. Yanti, M., Riandi, & Suhandi, A. (2020). Pedagogical content knowledge (PCK) of science teachers based on content representation (CoRe). 1521(4), 042119. https://doi.org/10.1088/1742-6596/1521/4/042119
26. Yanti, M., S, M. I., & Astiti, N. Y. (2024). Analysis of Pedagogical Content Knowledge (PCK) Capabilities of Preservice Elementary School Teachers through Science Learning Planning. Journal of Elementary Educational Research, 4(2), 157–173. https://doi.org/10.30984/jeer.v4i2.91538
27. Yuliariatiningsih, M. S., Halimah, L., Yanthi, N., & Wahyuningsih, Y. (2019). Profile pedagogical content knowledge (pck) of primary school teacher in science teaching. 11(2), 135–140. https://doi.org/10.17509/EH.V11I2.17481