

Comparative Study on Science Teaching Competence in Relation to Selected Demographic Variables

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Abstract

The present study aims to examine the level of science teaching competence among graduate teacher trainees and to analyze the influence of selected demographic variables, namely gender, locality, and family type, on their teaching competence. Science teaching competence is considered a crucial component of effective classroom instruction, as it directly affects students' understanding, scientific thinking, and academic achievement. To achieve the study's objectives, a descriptive survey method was adopted. The sample comprised 320 graduate teacher trainees, selected via simple random sampling to ensure adequate representation of diverse demographic groups. Data were collected through a self-constructed Science Teaching Competence Questionnaire consisting of 47 positively worded items measured on a five-point Likert scale. The tool assessed various dimensions of science-teaching competence, including subject knowledge, instructional strategies, classroom management, the use of teaching aids, and evaluation practices. The collected data were analyzed using appropriate inferential statistical techniques, such as t-tests and chi-square tests to test the formulated hypotheses. The t-test analysis revealed statistically significant differences in science teaching competence with respect to gender ($t(318) = 2.003, p < .05$), locality ($t(318) = 4.180, p < .001$), and family type ($t(318) = 6.618, p < .001$). However, the chi-square analysis examining the association between gender and competence levels showed no statistically significant relationship at the .05 level. The results highlight demographic disparities that need to be addressed in teacher education programs. The study emphasizes the importance of designing context-sensitive, inclusive teacher-training initiatives that cater to the diverse backgrounds of teacher trainees, thereby enhancing their professional competence and effectiveness in science teaching.

Keywords: science teaching competence, graduate teacher trainees, classroom management, instructional strategies

Introduction

Teacher competence is widely recognized as a critical determinant of effective teaching and meaningful learning outcomes. In the context of science education, teaching competence extends beyond mere subject mastery to encompass pedagogical skills, classroom management, creativity, reflective practice, and the ability to engage learners actively in scientific inquiry (Sharma, 2021; Zhang, 2021). Science teaching competence therefore, refers to a teacher's capacity to integrate scientific knowledge with appropriate instructional strategies that promote critical thinking, problem-solving, and experiential learning among students (Thomas et al., 2023).

Contemporary teacher education emphasizes competence-based preparation to meet the evolving demands of classrooms and curriculum reforms (Patel & Kaur, 2020; Yadav, 2024). Studies have shown that well-prepared teachers significantly enhance classroom engagement and student achievement, highlighting the importance of systematic competence development during pre-service training (Gupta, 2024; World Bank, 2022). Reflective and experiential approaches in teacher education further strengthen pedagogical effectiveness,

particularly in science teaching, where conceptual clarity and hands-on learning are essential (Banerjee, 2023; Thomas et al., 2023). At the global level, organizations such as the United Nations Educational, Scientific and Cultural Organization (UNESCO, 2023) and the World Bank (2022) emphasize teacher competence frameworks as key drivers of quality education and sustainable development.

Despite these advancements, research indicates that teaching competence is not uniformly developed among teacher trainees. Demographic variables such as gender, locality, and family background have been found to influence access to resources, motivation, and professional growth (Nair & Devi, 2021; Ramesh & Joseph, 2020). Urban-rural disparities in teacher training outcomes further suggest unequal exposure to pedagogical opportunities and institutional support (Kumar & Singh, 2022). Empirical evidence also points to variations in competence across subject streams and training contexts, underscoring the need for comparative analyses (Getahun, 2025).

In the Indian context, studies have highlighted the effectiveness of targeted interventions in enhancing teaching competency among graduate teacher trainees (Sasikumar et al., 2016). However, there remains a need to examine systematically how

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selected demographic variables influence science teaching competence. Such an understanding is essential for designing inclusive, equitable, and context-sensitive teacher education programs that address existing disparities and strengthen the professional preparation of future science teachers.

Review of the Related Literature

Teaching competence has been extensively discussed in educational research as a multidimensional construct comprising subject knowledge, pedagogical skills, classroom management, and reflective abilities. Sharma (2021) proposed a comprehensive theoretical framework outlining the core dimensions of teaching competence, emphasizing the integration of cognitive, affective, and practical domains. In science education, pedagogical competence is particularly significant, as it requires teachers to translate abstract scientific concepts into meaningful learning experiences (Zhang, 2021).

Competence-based teacher education has gained prominence in recent years. Patel and Kaur (2020) highlighted the role of structured teacher education programs in building professional competence, while Yadav (2024) emphasized emerging perspectives that align teacher preparation with outcome-based educational standards. Reflective and experiential learning approaches have also been identified as effective strategies for enhancing teaching skills (Banerjee, 2023; Thomas et al., 2023). At the policy level, UNESCO (2023) and the World Bank (2022) underscored the importance of teacher competence frameworks in improving educational quality globally.

Empirical studies have explored the influence of demographic variables on teaching competence. Ramesh and Joseph (2020) reported gender-based differences among trainee teachers, while Kumar and Singh (2022) identified significant urban-rural disparities in teacher training outcomes. Similarly, Nair and Devi (2021) found that family background plays a crucial role in shaping teacher motivation and professional development. Comparative analyses across subject streams also reveal variations in instructors' competencies (Getahun, 2025). Furthermore, Sasikumar et al. (2016) demonstrated that targeted neurocognitive interventions significantly enhanced teaching competency among graduate teacher trainees.

The reviewed literature indicates that both institutional practices and demographic factors influence teaching competence, warranting further comparative investigation in science education.

Need and Importance of the Study

The effectiveness of science education largely depends on teachers' teaching competence, especially during the pre-service training period, when professional skills are systematically developed. Although teacher education programs aim to build strong pedagogical and subject competence, differences may exist among graduate teacher trainees due to demographic factors such as gender, locality, and family type. Therefore, it is necessary to examine science-teaching competence from a comparative perspective to clearly understand these variations.

This study is important because it provides empirical evidence on how selected demographic variables influence science-teaching competence. The findings will help teacher educators and curriculum planners design more inclusive and context-sensitive training programs. It will also assist institutions in identifying areas where additional support, guidance, or intervention is needed to improve trainees' competence levels.

The scope of the study is confined to graduate teacher trainees and focuses specifically on science teaching competence in relation to selected demographic variables. The results may serve as a foundation for further research and for strengthening teacher education practices aimed at improving the quality of science teaching.

Objectives

1. To determine the level of science teaching competence among graduate teacher trainees.

2. To analyze the differences in science teaching competence of graduate teacher trainees with respect to gender, locality, and family type.
3. To examine the association between gender and levels of science teaching competence among graduate teacher trainees.

Hypotheses

1. There is no significant difference in science teaching competence between male and female graduate teacher trainees.
2. There is no significant difference in science teaching competence between rural and urban graduate teacher trainees.
3. There is no significant difference in science teaching competence between graduate teacher trainees belonging to joint families and those from nuclear families.
4. There is no significant association between gender and the level of science teaching competence of graduate teacher trainees.

Methodology

Design

The present study employed a descriptive survey design to examine the level of science teaching competence among graduate teacher trainees and to analyze differences based on selected demographic variables. The descriptive method was considered appropriate as it enables the systematic collection and analysis of data to describe existing conditions and compare groups without manipulating variables.

Population

The study population consisted of all graduate teacher trainees enrolled in science methodology courses at recognized teacher education institutions. These trainees were undergoing pre-service teacher education and were exposed to theoretical and practical components of science teaching.

Sample

From the identified population, a sample of 320 graduate teacher trainees was selected using simple random sampling. Stratification was conducted to ensure adequate representation by gender, locality (rural and urban), and family type (joint and nuclear). This method helped obtain a balanced, representative sample for meaningful comparative analysis.

Tool

Data were collected using a self-developed instrument titled the Science Teaching Competence Questionnaire (STCQ). The questionnaire comprised 47 positively worded statements measured on a five-point Likert scale ranging from "Strongly disagree" (1) to "Strongly agree" (5). The tool covered major domains such as pedagogical planning, classroom management, instructional strategies, and learner evaluation. Content validity was established through expert review, and the instrument's reliability was confirmed with a high internal consistency coefficient ($\alpha = 0.86$), indicating that the tool was reliable for the study. The total possible score on the STCQ ranged from 47 to 235. For the purpose of interpretation and chi-square analysis, the total scores were categorized into three levels of competence using equal interval classification method. Scores ranging from 47-109 were classified as "Low" competence, 110-172 as "Moderate" competence, and 173-235 as "High" competence. These cutoff scores were determined by dividing the total score range into three equal categories to ensure objective classification of teacher trainees into competence levels.

Results

Table 1

Comparison of Science Teaching Competence of Graduate Teacher Trainees with Respect to Selected Demographic Variables

Variables	n	M	SD	t-value	df	p-value
Gender						
Male	128	175.3	4.3	2.003	318	.046
Female	192	174.3	4.9			
Locality						
Rural	176	173.7	4.6	4.180	318	.001
Urban	144	175.9	4.5			
Type of Family						
Joint	128	173.7	4.2	6.618	318	.001
Nuclear	192	176.0	4.5			

Note. N = 320. Significant level = .05.

The table presents a comparative analysis of the science-teaching competence of graduate teacher trainees with respect to selected demographic variables, including gender, locality, and family type. In terms of gender, $t = 2.003$, $p = .046$, indicating a statistically significant difference at the .05 level. Male teacher trainees ($M = 175.3$, $SD = 4.3$) demonstrated slightly higher science teaching competence than female trainees ($M = 174.3$, $SD = 4.9$). With regard to locality, $t = 4.180$, $p < .001$, which indicates a highly significant difference between rural and urban teacher trainees. Urban

trainees ($M = 175.9$, $SD = 4.5$) exhibited higher competence compared to rural trainees ($M = 173.7$, $SD = 4.6$). Similarly, for the family type, $t = 6.618$, $p < .001$, shows a statistically significant difference. Teacher trainees from nuclear families ($M = 176.0$, $SD = 4.5$) demonstrated higher science teaching competence than those from joint families ($M = 173.7$, $SD = 4.2$). Thus, the null hypotheses pertaining to gender, locality, and family type are rejected. The inclusion of exact p -values and degrees of freedom strengthens the statistical reporting and enhances scientific rigor.

Table 2

Association between Gender and Level of Science Teaching Competence of Teacher Trainees

Gender	High	Moderate	Low	Total	χ^2	df	p-value
Male	85	35	8	128	$\chi^2(2) = 0.84$	2	.656
Female	120	67	5	192			
Total	205	102	13	320			

Note. N = 320. Significant level = .05.

Table 2 presents the association between gender and categorized levels of science teaching competence among teacher trainees. The chi-square analysis yielded $\chi^2(2) = 0.842$, $p = .656$, which is greater than .05. Hence, the association between gender and competence level is not statistically significant. Although differences were observed in the mean competence scores between male and female trainees (as indicated in Table 1), the distribution of trainees across high, moderate, and low competence categories did not differ significantly by gender. Therefore, the null hypothesis stating that there is no significant association between gender and the level of science teaching competence is accepted.

Discussion

The findings of the present study indicate that science teaching competence among graduate teacher trainees differs significantly with respect to gender, locality, and family type. The significant gender difference observed in mean competence scores is consistent with the findings of Ramesh and Joseph (2020), who reported variations in teaching competence between male and female trainee teachers.

However, the chi-square analysis revealed no significant association between gender and the three levels of science teaching competence (high, moderate, and low). This indicates that although a statistically significant difference exists in the mean competence scores of male and female trainees, the overall distribution of trainees across competence categories remains comparable. In other words, both male and female trainees are proportionately represented in high, moderate, and low competence groups. This finding suggests that gender may influence average performance levels but does not substantially determine categorical competence classification.

This result partially supports earlier research suggesting that gender differences in teaching competence may be dimension-

specific rather than structurally categorical. It also implies that science teacher education programs provide relatively equitable opportunities for competence development for both genders, thereby minimizing disparities at broader classification levels.

The significant difference between rural and urban teacher trainees aligns with the study by Kumar and Singh (2022), who identified urban-rural disparities in teacher training outcomes due to differences in exposure, institutional facilities, and access to professional development opportunities. Urban trainees may benefit from better academic environments and technological resources that enhance their competence in science teaching. These findings also reflect broader concerns raised in UNESCO (2023) and the World Bank (2022) reports, which emphasize equitable development of teacher competence across diverse contexts.

The significant variation across family types supports the findings of Nair and Devi (2021), who highlighted the influence of family background on teacher motivation and professional growth. The results further resonate with the competence-building perspectives proposed by Patel and Kaur (2020) and Yadav (2024), emphasizing structured and supportive training environments. Additionally, the enhancement of teaching competency reported by Sasikumar et al. (2016) suggests that targeted interventions can bridge demographic disparities.

The results reinforce the existing literature and underscore the importance of context-sensitive, inclusive science teacher education programs.

Conclusion

The present study examined science-teaching competence among graduate teacher trainees in relation to selected demographic variables, including gender, locality, and family type. The findings revealed significant differences in science teaching competence with respect to these variables, indicating that

demographic factors play an important role in shaping professional competence during pre-service training. Urban trainees and those from nuclear families demonstrated comparatively higher levels of competence, while gender differences were observed in mean scores. However, no significant association was found between gender and competence levels, suggesting that male and female trainees possess comparable potential when provided equal learning opportunities. The study highlights the importance of context-sensitive and inclusive teacher education programs that address demographic disparities. Strengthening institutional support, providing equitable resources, and implementing targeted training interventions can enhance science-teaching competence and prepare effective future science teachers.

Recommendations and Implications

Based on the findings of the present study, several recommendations and implications are suggested to strengthen science teacher education and enhance teaching competence among graduate teacher trainees. Since significant differences in science teaching competence were found by gender, locality, and family type, teacher education programs should adopt inclusive and differentiated instructional strategies. Special support mechanisms, mentoring, and confidence-building activities may be incorporated to address gender-related variations in teaching competence.

The significant urban-rural differences in science teaching competence indicate the need for improving infrastructure, learning resources, and pedagogical exposure in rural teacher education institutions. Regular training workshops, digital learning resources, and exposure to innovative science-teaching practices should be provided to rural teacher trainees to bridge the competence gap. Teacher education institutions may also promote collaborative learning and peer mentoring between rural and urban trainees.

The influence of family type on science teaching competence highlights the importance of providing academic and emotional support systems within teacher education programs. Counseling services, academic guidance, and flexible learning opportunities can help trainees from diverse family backgrounds enhance their professional competence. Furthermore, the finding that gender is not significantly associated with categorized competence levels suggests that all trainees have equal potential when provided with appropriate learning environments.

The implications of the study extend to teacher educators, curriculum developers, and policy makers. The results support the development of context-sensitive and competence-based teacher education curricula aligned with national and international teacher competence frameworks advocated by UNESCO and the World Bank. Overall, the study underscores the need for equitable and targeted interventions to improve science teaching competence and ensure quality science education.

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