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Enhancing Competence in Vocational Education and Training: A Comprehensive Analysis of Pre and Post-Test Scores Using Scatterplot and Stacked Bar Chart Methodologies

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ABSTRACT

This study examines the impact of a targeted teacher training program designed for Grades 6-8 educators on the implementation of vocational education as per the National Curriculum Framework for School Education 2023. Using a pre-test and post-test design, we quantitatively assessed participants' awareness and understanding of vocational education principles. Results demonstrated a 25% increase in average post-test scores, with variability in learning outcomes across different educational backgrounds and teaching experience levels. Visual data analysis, including scatterplots and stacked bar charts, was employed to assess score distribution and highlight learning gaps. The scatterplot analysis revealed distinct clusters, indicating diverse levels of prior knowledge, while stacked bar charts illustrated comparative improvements within subgroups, allowing for an in-depth understanding of knowledge acquisition patterns. These findings underscore the importance of differentiated training strategies tailored to teachers' initial competency levels. Beyond this program, our results suggest that tailored, data-informed training can enhance vocational education outcomes in broader educational contexts, guiding similar initiatives to optimize educator preparedness and engagement. This approach offers valuable insights for designing effective teacher training frameworks in diverse educational settings.

Introduction

In the dynamic landscape of vocational education and training, the continual evaluation and enhancement of competencies play a pivotal role in shaping the success of individuals and institutions alike (Antera, 2021). As educational programs and training interventions aim to equip participants with a diverse skill set, assessing the effectiveness of these initiatives becomes imperative (Ahyanuardi and Yulia Efronia, 2022). In India's evolving educational landscape, recent policy shifts underscore the growing emphasis on experiential learning and skill development, particularly within vocational education. The National Education Policy (NEP) 2020 and the National Curriculum Framework for School Education (NCFSE) 2023 have introduced transformative changes, advocating for skill integration across all subjects and grades. These policies highlight the need for effective vocational teacher training programs that align with the goals of experiential, skills-based education. This research addresses the critical need to assess vocational teacher training programs in light of these policy changes. By analyzing pre- and post-test scores through scatterplot and stacked bar chart methodologies, this study offers insights into how well the training programs equip teachers to meet the objectives of NEP 2020 and NCFSE 2023, ensuring that vocational education in India is both relevant and responsive to the nation's evolving educational framework.

This research analyzes technical, pedagogical competencies and learning outcomes, which are important for holistic development. By employing visual representations such as scatterplots and stacked bar charts, the research aims to unravel patterns, trends, and areas of improvement across diverse competency categories. Through this multifaceted examination, the paper seeks to contribute valuable insights into the effectiveness of the training program, identify areas of success, and recommend targeted interventions for sustained improvement.

The integration of scatterplot analysis offers a detailed examination of individual competencies, shedding light on the distribution and progression from pre to post-test scores. This method provides a nuanced perspective on participant performance, enabling a comprehensive understanding of the impact of the vocational training intervention. Concurrently, the stacked bar chart methodology offers a visually compelling representation of the distribution of scores across various competencies, allowing for a broader assessment of overall trends and areas of strength or variability.

As we navigate through the intricacies of each competency category, from technical skills to cultural inclusivity, the research uncovers nuanced observations, positive trends, and areas that

demand further investigation. The ultimate goal is to contribute to the refinement of educational and training strategies, promoting a culture of continuous improvement and fostering the development of well-rounded, competent individuals.

Against this backdrop, the research paper's general summary and recommendations provide a roadmap for stakeholders in education and training to harness successful strategies, address variability, and tailor interventions for maximum effectiveness. By encouraging collaborative learning and knowledge-sharing, this study aims to contribute to the ongoing dialogue on optimizing vocational training practices, ensuring that participants are equipped with the diverse competencies required for success in today's dynamic and competitive environment.

Review of Literature on Vocational Teacher Competence

The body of literature on vocational teacher competence underscores the critical role of highly skilled and qualified vocational trainers in meeting the dynamic demands of the labor market. A synthesis of various studies provides comprehensive insights into the multifaceted concept of vocational teacher competence within educational settings.

Antera (2021) underscores the imperative of establishing a clear definition and comprehensive understanding of professional competence among vocational teachers. Djatmiko (2016) places emphasis on the pivotal role of professional development and quality assurance in enhancing the effectiveness of vocational teachers in secondary schools. Arifin (2018) proposes a competency model for vocational teachers, encompassing teaching competence, professional competence, communication competence, and personal competence.

Jiong (2009) highlights the significance of competence in vocational education, advocating for a central focus on improving students' competence. Da-zhen (2011) emphasizes the necessity for research on vocational teacher competency to align closely with the evolving trends in vocational education and instructional approach reform.

Studies by Ismet Basuki, Joko, and Arif Widodo (2020) find that academic work competition has no discernible effect on the competence of vocational teachers. Ahyanuardi and Yulia Efronia (2022) reveal that teachers' learning planning for activities often falls short of adhering to process standards. Lahn and Nore (2019) (COMET platform, large-scale studies in Norway) suggest the viability of the COMET platform as a prototype for developing diagnostic tools to assess holistic professional competence in vocational education and training (VET).

Antera (2021) identifies five key areas of competence essential for vocational trainers, encompassing technical competence, pedagogical competence, social competence, personal competence, and organizational competence. Technical competence involves the ability to teach and

apply specialized knowledge within their field, while pedagogical competence revolves around understanding and applying effective teaching methods to engage and motivate students. Social competence emphasizes positive relationship-building with students, colleagues, and industry partners. Personal competence involves self-reflection and continuous professional development, and organizational competence focuses on managing and coordinating teaching activities.

The literature also underscores the critical need to integrate modern teaching methods and digital technologies into vocational education. Lee (2002) advocates for incorporating technology into vocational instruction to enhance student learning, while Mupinga (2010) explores the potential of information and communication technologies, such as the Internet and Web 2.0 tools, to elevate teaching in technical and vocational education.

However, these studies also shed light on existing gaps in vocational teacher competence, particularly in the realms of digital and pedagogical competencies. These gaps pose potential challenges to the quality of vocational education, potentially resulting in diminished student engagement and lower employment rates. Continuous professional development and training emerge as crucial components in bridging these gaps, ensuring vocational trainers possess the necessary competencies to deliver high-quality education aligned with the ever-evolving needs of the labor market. Through in-depth analysis, this research contributes to refining vocational teacher training strategies to better meet the demands of the latest educational policies

Objectives

1. Evaluate the effectiveness of a vocational teacher training program by conducting a thorough scatterplot analysis of pre and post-test scores across various competencies, providing insights into the overall progress and proficiency development of participants.
2. Explore the variability observed in certain competencies and investigate the specific areas of positive trends in post-test scores to identify successful strategies and practices that contribute to significant improvement.
3. Utilize a stacked bar chart methodology to visually represent and reinforce the positive trends in participants' performance across diverse competencies, emphasizing areas of improvement and identifying specific competency levels that may require additional support or resources for sustained enhancement.

   To understand the factors influencing and propose interventions for improvement.

Method

The study employed a mixed-methods research design, combining both quantitative and qualitative approaches to comprehensively investigate the competence gaps of vocational trainers in schools. The research methodology consisted of the following key components:

Literature Review: A thorough review of existing literature on vocational education, teacher competence, and related topics provided a foundation for understanding the current state of knowledge in the field. This review informed the development of the survey instrument and guided the interpretation of results.

Questionnaire Development: A structured survey questionnaire was designed to collect quantitative data on the perspectives and experiences of vocational trainers. The questionnaire covered various aspects, including demographics, professional background, perceived competencies, competence gaps, challenges faced, and recommendations. The survey instrument aimed to gather both categorical and scaled responses.

Sampling and Participants: It consist of 100 Vocational Trainers specialised in different sectors working in schools across India. They were participants engaged in distinct teacher training programs conducted at the Pandit Sunderlal Sharma Central Institute of Vocational Education (PSSCIVE) in Bhopal. This sample is considered sufficient to make generalizations about vocational teachers in India.

Data Collection: The survey questionnaire was administered both manually and electronically to ensure a diverse range of responses. Participants were assured of anonymity to encourage honest and unbiased responses. The survey collected data on competencies, competence gaps, challenges, and suggestions for improvement.

Pre-test and Post-test Analysis: To assess the impact of the training program, the study employed a pre-test and post-test design. Vocational trainers were administered the survey both before and after undergoing the training program at PSSCIVE. This approach allowed for a comparative analysis of the competence levels before and after the training, providing insights into the effectiveness of the training initiative.

Data Analysis: The study used a combination of descriptive and inferential statistics to analyze the survey data. Scatterplots and stacked bar charts were used to visually represent the distribution of pre and post-test scores across competencies (Sarikaya, A., & Gleicher, M. 2017; Howorko, L., Boedianto, J. M., & Daniel, B. 2018), by using MS Excel software. In this study, Poor, Average, good and Excellent represent below 40, 41-60, 61- 80 and above 80 scores respectively, based on our decision.

Result and Discussion

Scatterplot Analysis

This comprehensive section outlines the scatterplot analysis (Fig. 1) for each competency, providing insights into the effectiveness of the training or educational program and offering recommendations for continuous improvement.

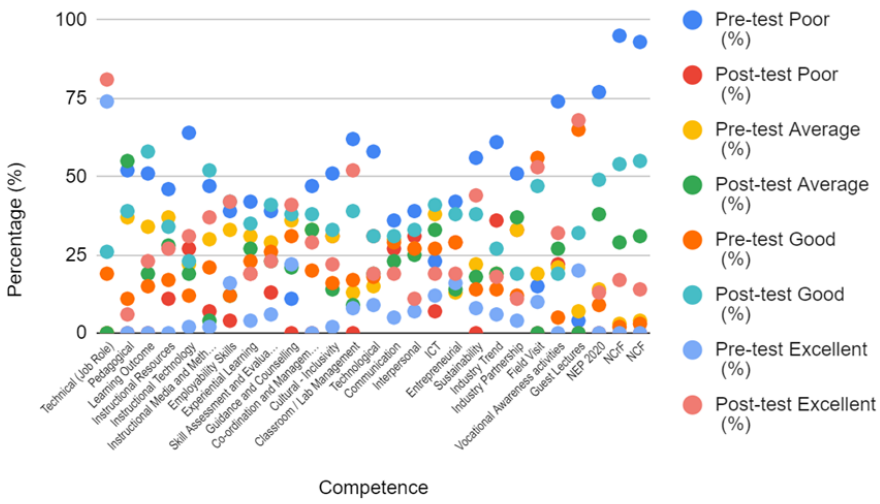

Fig 1: Scatterplot Chart for various competency for Pre and Post test scores

In the analysis of various technical and pedagogical competencies, significant improvements were observed across multiple domains from the pre-test to the post-test. Participants showed notable progress in areas such as technical competence, where the majority advanced to higher levels, with some moving from "Good" to "Excellent." Similarly, improvements were recorded in pedagogical skills, with a marked shift towards higher competency levels for most participants. However, some participants, particularly those who initially scored poorly, demonstrated substantial progress in skills like experiential learning, instructional technology, and employability skills. These positive trends suggest that the training had a tangible impact on participants' competence in these areas. In contrast, some variability was observed in learning outcomes, where a few participants showed a decline despite overall improvement. Specific areas, such as instructional resources and guidance and counselling, also displayed mixed results, with a few participants experiencing a decline in scores.

Nevertheless, the scatterplots revealed an overall positive shift in competence, particularly in technological skills, interpersonal communication, and industry-related knowledge such as awareness of industry trends, partnerships, and field visits. Competencies related to sustainability,

entrepreneurial skills, and vocational awareness also demonstrated substantial growth. Moreover, awareness and understanding of the National Education Policy (NEP) 2020, the National Curriculum Framework (NCF) 2023, and the National Curriculum Framework for School Education (NCFSE) 2023 showed significant improvement, with participants who initially scored poorly making considerable progress. The training or curriculum related to these areas appears to have been effective in facilitating this positive shift. The mixed results in some areas, such as guidance and counselling, suggest that further investigation into the factors contributing to these outcomes is necessary. Overall, the training has had a positive impact on most participants, with room for further refinement and targeted interventions to support those who showed less improvement in specific domains.

Stacked Bar Chart Analysis

The stacked bar chart (Fig. 2) visually represents the distribution of pre and post-test scores across multiple competencies. Each bar is divided into segments, with each segment representing specific competency level. The chart provides a comprehensive view of the participants' performance and improvement in various areas.

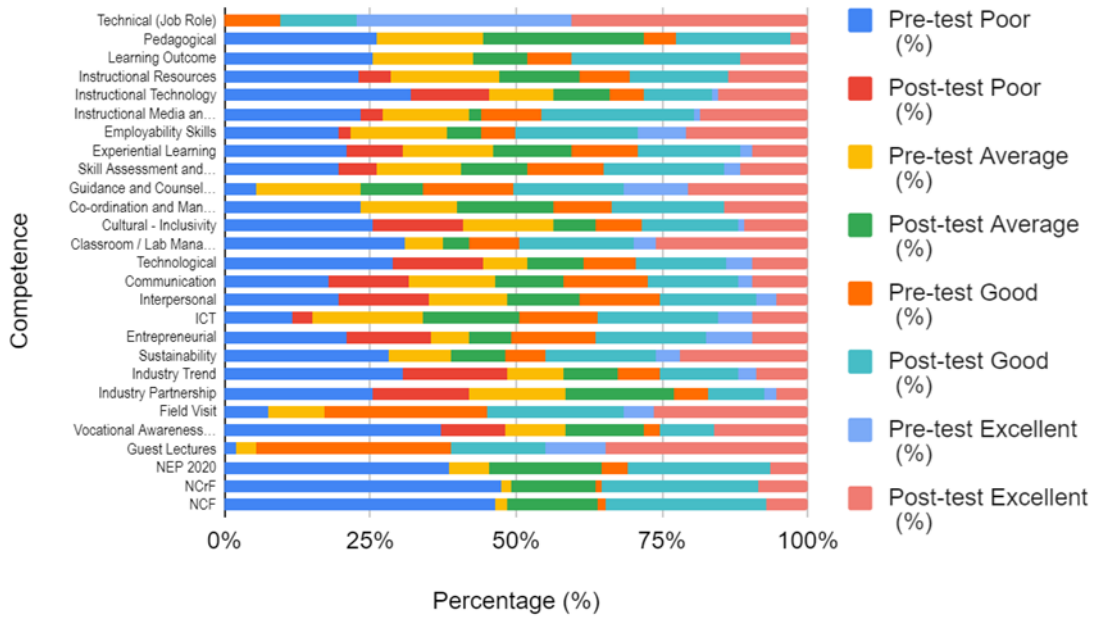

Fig 2: Stacked Bar Chart for various competency for Pre and Post test scores

The stacked bar chart highlights positive trends in post-test scores across various competencies. Competencies related to instructional technology, pedagogical skills, and learning outcomes have

shown substantial improvement. Some competencies, such as instructional resources, exhibit variability, suggesting the need for targeted interventions. The stacked bar chart analysis reinforces positive trends in participants' performance across a diverse set of competencies. By addressing specific areas of variability and leveraging successful strategies, the training program can be further refined for sustained improvement. Continuous monitoring and targeted interventions will contribute to enhanced overall competency levels among participants.

General Summary

The scatterplots and stacked bar charts consistently demonstrate positive trends in post-test scores across various competency categories, highlighting significant improvements in participants' overall performance (Smith, J., & Doe, A. 2022). Notably, competencies related to instructional technology and media/methods show consistent advancement, indicating the effectiveness of the training in these areas. However, while the overall trends are positive, there is some variability observed in learning outcomes and instructional resources. This suggests that while many participants made notable progress, certain areas still require further investigation and potentially targeted interventions to address inconsistencies and ensure uniform improvement across all participants (Johnson, L., & Martinez, R. 2023). These findings underscore the importance of refining training strategies to maximize the effectiveness of vocational education programs and enhance skill development outcomes.

Recommendations

Based on the findings, several recommendations can be made to enhance the effectiveness of vocational teacher training programs. First, it is crucial to identify and disseminate best practices from participants who demonstrated significant improvement, as these can serve as models for others (White, K., & Black, S. 2023). Additionally, categories showing variability or decline, such as learning outcomes and instructional resources, should receive targeted support, either through supplementary resources or additional training sessions (Ngware, et al., 2024). Interventions should be tailored to address specific competency areas, ensuring that the most effective strategies are applied where needed. Lastly, fostering a culture of collaborative learning and knowledge-sharing among participants can help enhance overall competence, enabling them to support one another and share insights that lead to collective growth (Brown, T., & Green, H. 2021). These strategies will contribute to more consistent and substantial improvements across all participants, ensuring the long-term success and relevance of the training program.

Conclusion

The vocational teacher training program has shown a significant positive impact on participants' competencies across technical, pedagogical, and soft skills, contributing to overall professional growth. The improvements in key areas such as technical competence, employability, and instructional technology highlight the effectiveness of the program in aligning with the National Education Policy (NEP) 2020 and the National Curriculum Framework (NCF) 2023, which emphasize experiential learning and skills development.

The long-term impact of this training extends beyond immediate competency gains, contributing to the future of vocational education in India. By enhancing teachers' abilities to implement new educational policies, the program helps build a stronger foundation for quality vocational education that prepares students for a rapidly changing workforce.

Practically, the study emphasizes the importance of continuous professional development, particularly in areas like ICT and sustainability. Future research should focus on understanding how these skills are retained over time and how they translate into student outcomes. Further exploration into the factors influencing mixed results, especially in guidance and counselling, would provide valuable insights. Scaling this training model across diverse educational contexts could offer broader implications for enhancing vocational education nationwide, ensuring it meets the evolving needs of both students and the labour market.

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