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Science Teachers' Professional Development and Teaching Competence: Implications for Educational Practice

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Abstract

This paper analyzes the professional development (PD) and teaching competence (TC) of 207 junior high school science teachers from 46 public schools of various sizes and locations in the Division of Agusan del Sur, Philippines. This study aims to present a comprehensive description on the level of teachers' PD in four key areas: career goal practices (CGP), professional ability (PA), promotion speed (PS), and in participation in seminars and trainings (PST). Moreover, it is also concern to evaluate the level of teachers' competence in terms of self-efficacy (SE), technological pedagogical content knowledge (TPACK) and teaching practices (TP). The study utilized a quantitative descriptive research design of which findings revealed that science teachers exhibited very high labels of PD specifically in the areas of CGP and PA which suggests that teachers reflect a strong commitment to continuous growth. Furthermore, data also revealed a very high level of competence in terms of SE and TP which suggests that teachers are confident in their ability to manage classrooms and deliver effective lessons. However, data showed that the lowest confidence is in the integration of technology in teaching, specifically within the TPACK framework, and therefore identified as an area for further improvement. Nonetheless, teachers generally felt competent in using technology but there is a continued need to target PD that bridges the gap between technology and pedagogy. Thus, the study underlined the importance of continuous and contextualized PD programs to address the areas of science education and pedagogy to improve the teaching and learning process.

Keywords: Professional Development, Teaching Competence, Science teachers

Introduction

In a fast-evolving science education where continuous advancements in knowledge, technology and pedagogical approaches requires sustained professional development (PD), teaching competence (TC) is often associated with the quality of the teaching-learning process. Moreover, the quality of instruction is strongly associated with continuous PD of the educators [1]. PD is the ongoing, planned activities like training, seminars, and workshops that aim to help science teachers learn more, improve their teaching, and move up in their careers. It was also emphasized that reflective and ongoing professional learning makes teaching better and helps students learn better [2]. In addition, teacher competence (TC) is very important for how well teachers teach, how they make decisions about how to teach, and how engaged students are [3]. This indicates that teachers who are competent are more likely to help students to learn better. On the other hand, TC is the sum of a teacher's self-efficacy, teaching style, and ability to combine content, pedagogy, and technology. It reflects the teacher's capacity to deliver effective instruction and support student learning. Furthermore, teachers with higher levels of competence are more likely to provide more organized instruction which can eventually improve students' academic performance. Thus, this study determines the PD and TC of science teachers specifically, the study aims to determine the level of PD in terms of career goal practice (CGP), professional ability (PA), promotion speed (PS), and participation in seminars and training (PST). In addition, it seeks to assess the level of science TC in relation to self-efficacy (SE), technological pedagogical content knowledge (TPACK), and teaching practices (TP).

The study is primarily anchored on Self-Efficacy Theory by Woodcock et.al. (2022) which highlighted how teachers' belief in their abilities affects their professional competence and teaching instruction [4]. The theory stressed that teachers with strong self-efficacy are more likely to persevere in overcoming instructional challenges, exhibits effective teaching strategies and maintain positive learning environments. In addition, the study anchored on the Cognitive Load Theory of Sweller et.al. (2011) which highlighted the significance of managing cognitive demands during the teaching process to facilitate a meaningful learning experience [5]. Another theory on which the study is anchored to is the the Technological Pedagogical Content Knowledge (TPACK) framework proposed by Mishra and Koehler (2006) [6]. This theory claimed that integration of content knowledge, pedagogy, and technology is necessary to attain an effective science teaching in the current classroom setting. Lastly, one of the frameworks of the study is the Constructivist Learning Theory of Piaget (1972) which underscores that active learning and knowledge construction are essential component for the learners to acquire a better learning experience [7].

Methodology

The study employed a quantitative descriptive research design to address the identified research problems. It was conducted in the Division of Agusan del Sur, in Caraga Region of Mindanao, Philippines. The research covered forty-six (46) public junior high schools within the division, representing a range of school sizes classified as small, medium, large, and mega based on student population. The diversity of the learners from the participating schools based on geographic locations and socioeconomic contexts provides an appropriate setting to examine the PD and TC of the teachers in their varied classroom environments.

The respondents of the study were the 207 junior high school science teachers that were teaching the subject for at least three (3) years and aged between 25 to 60 years old. These demographic profiles guaranteed a diverse and more significant data aligned with the objectives of the study. In addition, demographic profiles such as gender, civil status, educational attainment, and years of teaching were also collected to support analysis of TC and PD in science education. Based on the data gathered, the respondents included 64 males and 143 females. Among those respondents, majority were married with a total of 139 teachers while 55 were single, seven (7) were widowed and six (6) were separated. As to their educational attainment, 123 of them held a bachelor's degree, 39 teachers had units earned from a master's program, 35 had a master's degree, six (6) had earned units on doctoral degree and the remaining four (4) are graduates of a doctoral program. Teacher respondents have varied teaching experiences with 46 teachers have three (3) to five (5) years of teaching experience, 63 teachers have six (6) to 10 years in the service, 49 with 11 to 15 years, 25 teachers with 16 to 20 years and the remaining 24 with more that 20 years. These diverse range of profiles assured a well-rounded perspective of academic qualifications, professional maturity and instructional experience in science education.

This study used adapted and researcher-made survey instruments. An adapted instrument was used for teachers' competence. In contrast, a researcher-made instrument was used for teacher professional development. Moreover, the validity and reliability of the instrument were considered. First, the instrument underwent validation from the experts. Then, questions were modified based on the experts' suggestions and recommendations to observe linearity and parallelism. Considering this, the comments and suggestions of the expert-validators were incorporated into the final draft of the instruments. Further, a pilot test was conducted among the 30 randomly selected teachers of a non-respondent school, preferably in private schools. Accordingly, Cronbach's alpha coefficient was used to determine the internal consistency of the items of the survey instruments. A higher score signifies a more reliable generated scale is, and all the items on such measures reflect the same underlying construct [8].

The questionnaire was divided into four parts. Part I was for the profile of the respondents. Part II of the instrument focused on measuring teachers' PD. It comprised four key indicators: CGP, PA, PS, and PST. The overall Cronbach's alpha coefficient for this section was 0.952, indicating excellent internal consistency. This means that the items in the questionnaire were highly reliable and consistently measured the construct of professional development. Part III was the questionnaire on TC which includes three indicators such as SE, TPACK and TP. SE questionnaire was adapted form the PISA 2021 Teacher Questionnaire while the questionnaire for TPACK was adapted from Hosseini et. al. (2012) [9]. And lastly, the questionnaire on TP was adapted from Glenn (2018) [10]. The overall Cronbach's alpha coefficient of 0.912 indicates a high internal consistency level among the items which indicates the items reliably measured the intended construct and the respondents consistently answered related questions. The data gathered for the demographic profiles, PD and TC were then analyzed using appropriate descriptive and inferential statistical tools. Frequency counts and percentages were used to describe the profile of the respondents and summarize responses to each indicator. Weighted mean was employed to determine the level of science teachers' professional development and teaching competence across the identified dimensions.

Results

Table 1: Level of Professional Development of Science Teachers

Indicators	**Mean**	**Adjectival Rating**
Career Goal practice	4.58	Very High
Professional Ability	4.67	Very High
Promotion Speed	4.43	Very High
Participation to Seminars and Training	4.31	Very High
Overall Mean	**4.50**	**Very High**

Table 1 presents the level of professional development of science teachers in terms of career goal practice, professional ability, promotion speed, and seminars and training conducted. The mean values ranged from 4.31 to 4.67, with an adjectival rating very high. The overall mean was 4.50, and the adjectival rating was very high.

Table 2: Level of Competence of Science Teachers

Indicators	Mean	Adjectival Rating
Self-Efficacy	4.72	Very High
Technological Pedagogical Content Knowledge (TPACK)	4.47	Very High
Teaching Practices	4.55	Very High
Overall Mean	**4.58**	**Very High**

Table 2 presents science teachers' competence level regarding self-efficacy, technological pedagogical content knowledge (TPACK), and teaching practices. The mean values ranged from 4.47 to 4.72, with an adjectival rating of very high. The overall mean was 4.58, and the adjectival rating was very high.

Discussions

Based on the results, data revealed that for the level of PD the indicator PA had the highest mean of 4.67 and is described as very high. This indicates that science teachers' PD for this indicator is always practiced and also, this suggests that they consistently engage in PD practices related to professional abilities enhancement. Result recommends that strengthening PA must be a key focus among science teachers and this may significantly contribute to the overall effectiveness of science instruction. Moreover, prioritizing continuous development for PA could improve instructional quality and eventually, improve learning outcomes. Sun et. al. (2021) underscores that continuous PD significantly augments teachers' instructional skills, pedagogical strategies and content knowledge which may results to better student engagement and outcomes in science [11]. Conversely, DeMonte (2020) argued that PD may be significant but its impact is limited if it is not contextualized with the classroom realities or if no support will be extended by the school leadership and resources [12]. Audisio et al. (2024) emphasized that PD that are sustained and well-supported can enhance instructional practices and student achievement, provided that it aligns with teachers' personal goals and classroom settings [13]. On the other hand, the indicator PST had the lowest mean of 4.31 with adjectival rating of very high which may indicate that teachers' PD in terms of this indicator is always practiced suggesting that while participation in seminars and trainings is regularly done, it may not be perceived to be significant or as frequently aligned to the needs of the teachers in the classroom as compared to other PD activities. Diliberti and Kaufman (2020) found out that despite teachers' frequent participation in mandated PD they still often question its applicability and effectiveness to address instructional challenges [14]. Moreover, Rivera and Tan (2020) revealed that while participation in seminars and training is often done, many teachers still perceive them as too generic or disconnected from their specific teaching realities, thus, limiting their practical impact [15]. Similarly, Tadesse et. al. (2021) emphasized that for the PD programs to become impactful then it must be subject-specific, relevant, and contextually grounded [16]. This implied the necessity of critically evaluating the content, delivery methods and overall relevance of the proposed seminars and trainings for implementation to ensure that these activities align to the gaps in a real classroom setting to effectively address the current instructional challenges in science education. By doing so, such initiatives can result to deeper engagement and promotion of the practical application of newly acquired strategies for elevating the quality of science instruction.

The overall mean for the level of PD of science teachers is 4.50, with an adjectival rating of very high which indicate that teachers consistently engage in growth opportunities across CGP, PA, PS and PST.

The emphasis given to PA implies the continued efforts of the teachers to develop more effective and appropriate instructional strategies and improve content-area proficiency that, over time, contribute to improved teaching quality. Meanwhile, teachers' high regard for promotion shows that they are aware of and motivated by instructional career pathways which is one of the incentives for continuous career improvement. Although, PST had the lowest mean among PD indicators, it is still rated as very high which implies that regular participation to PD is still evident despite concerns about content relevance.

For the level of TC, the indicator SE had the highest mean of 4.72 with an adjectival rating of very high which indicates that TC of the respondents in this indicator is consistently observed, suggesting that teachers strongly believe in their ability to effectively facilitate learning, manage classroom challenges, and confidently apply instructional strategies while adapting to the demands of science instruction. This implies that strengthening SE among teachers may lead to more effective teaching practices, increased motivation, and a greater willingness to adopt innovative methods in the classroom. Teachers with high SE are more likely to persist through difficulties and positively influence student engagement and achievement. Therefore, PD initiatives should reinforce teachers' self-belief by providing opportunities for mastery experiences, peer collaboration, and supportive feedback mechanisms, affirming their instructional competence. On the other hand, the indicator TPACK had the lowest mean of 4.47 with an adjectival rating of very high. This result indicates that science teachers' competence in terms of TPACK is consistently observed, suggesting that while they generally feel confident in integrating technology with pedagogy and content, it remains the area with the most room for growth compared to other competence indicators. This implies that despite their positive self-assessment, teachers still face subtle challenges in fully harmonizing technology use with subject content and instructional methods, possibly due to rapidly evolving digital tools or limited contextual training. Further, there is a continued need to enhance teachers' TPACK through targeted professional development initiatives that go beyond basic technology skills and focus on how digital tools can meaningfully support science pedagogy and content delivery. Supporting teachers with ongoing, subject-specific TPACK training and opportunities to experiment with emerging technologies in real classroom settings can further strengthen their competence and confidence in delivering engaging and effective science instruction.

Kurniawati et al. (2021) affirmed that many science educators possess a high level of TPACK, particularly in contexts where ongoing digital integration and professional development are institutional priorities, echoing the findings of consistently observed competence in this study [17]. However, Alayyar and Aldhoubi (2023) argued that despite teachers' self-reported confidence, practical limitations, such as lack of access to relevant digital tools, insufficient time for training, or superficial understanding of technology integration, often hinder the complete application of TPACK in the classroom [18]. These findings suggest that while teachers may express high competence in TPACK, targeted interventions and systemic support remain essential to ensure that such competence is translated effectively into classroom practice.

The overall mean for TC is 4.58, with an adjectival rating of very high. The results indicate that teachers consistently demonstrate strength in their competence across key indicators, SE, TPACK, and TP. This suggests that science teachers possess a strong belief in their ability to manage classroom dynamics and deliver content effectively (SE), skillfully integrate technology with pedagogy and content (TPACK), and apply appropriate instructional strategies that enhance student learning (TP). These findings imply that science teachers are well-prepared to meet the evolving demands of science instruction, and further investing in continuous professional development that reinforces these competencies can lead to even greater instructional effectiveness and improved student outcomes in science education.

Khine et al. (2022) emphasized that high SE among science teachers leads to more confident instructional delivery and adaptability in diverse classroom situations [19]. Similarly, Ghavifekr and Jafari (2021) found that well-developed TPACK positively correlates with effective teaching practices and improved student engagement [20]. However, Polly et al. (2020) noted that despite high self-reported TPACK scores, many teachers still struggle with the practical integration of technology in classroom settings, suggesting a potential gap between perceived and actual competence [21]. These findings imply that while science teachers may report strong capabilities, continuous support and evaluation mechanisms are essential to ensure these competencies translate into effective instructional outcomes.

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