

## CONTENT KNOWLEDGE AND PEDAGOGICAL COMPETENCE IN BIOLOGY OF JUNIOR HIGH SCHOOL TEACHERS: BASIS FOR AN ENHANCEMENT PROGRAM

**Roygen T. Pesalbon**

La Consolacion College Bacolod

<https://orcid.org/0009-0009-3022-4375> | [roygen.pesalbon@deped.gov.ph](mailto:roygen.pesalbon@deped.gov.ph)

### Abstract:

This study examined the content knowledge and pedagogical competence in Biology among Grade 10 science teachers in the Division of Tanjay City to inform a targeted enhancement training program. Grounded in Kolb's Experiential Learning Theory and Burch's Conscious Competence Theory, the research employed a descriptive-correlational design involving 39 junior high school teachers selected through purposive sampling. Data were gathered using a validated 27-item content knowledge test and a pedagogical competence self-assessment tool aligned with the Philippine Professional Standards for Teachers. Descriptive statistics, Mann-Whitney U, Kruskal-Wallis, and Spearman's rank correlation were used to analyze the data. Results showed that the teachers demonstrated high content competence and above average pedagogical competence, with no statistically significant differences when grouped according to teaching experience or educational attainment. Moreover, a weak and non-significant correlation was found between content knowledge and pedagogical competence, highlighting the independence of these two domains. The findings underscore the need for integrated professional development that enhances both what teachers know and how they teach, forming the basis for the proposed enhancement program titled SPECTRA: Strengthening Pedagogical and Content Teaching in Relevant Applications.

*Keywords: content knowledge, pedagogical competence, science education, professional development, enhancement program*

### Introduction:

Effective science education hinges on the dual pillars of content knowledge (CK) and pedagogical competence (PC), both of which are essential for fostering student engagement, critical thinking, and meaningful learning outcomes. Content knowledge allows teachers to deliver scientifically accurate information, while pedagogical competence empowers them to facilitate effective classroom instruction that caters to diverse learners (Adeoye et al., 2024; Benson et al., et al., 2020; Hume et al., 2019). As the demand for high-quality science education continues to grow, ensuring that teachers possess both domains of competence is vital for academic achievement, especially in content-heavy subjects like Biology.

Globally, studies emphasize the need for integrated teaching knowledge—particularly the fusion of CK and pedagogical content knowledge (PCK)—to improve science teaching. In Germany, Welter et al. (2021) found that limited content expertise among biology teachers impaired the conceptual clarity of instruction. Likewise, in Indonesia, Harlis et al. (2024) highlighted knowledge gaps in molecular biology even among experienced educators. PCK plays a crucial role in making such abstract scientific content more accessible. For example, Spanish teachers with high PCK were found to effectively use analogies and visual aids to simplify complex systems like the nervous and digestive systems (Tapia et al., 2023).

Parallel to these global observations, studies in the Philippines reveal a mixed landscape. While teachers in a meta-analysis study were reported to have strong CK (Hinampas & Fajardo, 2024), research from Capiz and Butuan City showed varying levels of pedagogical competence, with many educators requiring further training in instructional strategies and student engagement techniques (Gamayao & Biñas, 2021). Despite these insights, existing teacher development programs often fail to address CK and PC holistically.

Kolb's Experiential Learning Theory (ELT) and Burch's Conscious Competence Theory (CCT) provide a strong theoretical lens to understand the development of teacher competence. ELT emphasizes the transformation of

concrete teaching experiences into abstract understanding and practice, encouraging continuous learning through reflection and experimentation (McCarthy, 2016; Peterson & Kolb, 2017). Meanwhile, CCT highlights stages of competence from unconscious incompetence to unconscious competence—providing a framework for diagnosing and developing professional skills (Burch, 2014).

In the Philippine education context, the K–12 science curriculum introduced by the Enhanced Basic Education Act of 2013 (DepEd, 2019; DO No. 21 s. 2019) shifted towards a spiral progression approach, emphasizing conceptual depth over rote coverage. Yet, despite these reforms, many Grade 10 students struggle with key competencies in biology, partly due to gaps in teacher preparedness. This situation is exacerbated by systemic barriers such as lack of resources, minimal institutional support, and limited access to timely and relevant professional development (Cudal et al., 2024).

Given these realities, there is a compelling need to assess not only the current levels of CK and PC among Junior High School biology teachers, but also to determine how factors such as teaching experience and educational attainment affect these competencies. More importantly, the interrelationship between CK and PC remains underexplored, raising critical questions about whether mastery in one domain translates into excellence in the other.

This study sought to examine the content knowledge and pedagogical competence in Biology of Grade 10 science teachers in the Division of Tanjay City. Specifically, it explores whether there are significant differences in competence levels when grouped according to teaching experience and educational attainment, and whether there is a significant relationship between CK and PC. Grounded in ELT and CCT, the study ultimately aims to provide an evidence-based foundation for a targeted enhancement training program for science teachers.

### **Methodology:**

This study utilized a descriptive-correlational research design to investigate the levels of content knowledge and pedagogical competence in Biology among Grade 10 science teachers. The descriptive aspect aimed to determine the current competence levels of teachers, while the correlational component sought to identify potential relationships between the two variables. Comparative analyses were also conducted to examine whether significant differences existed in the competence levels of teachers when grouped according to teaching experience and educational attainment. This multi-faceted design allowed for a holistic understanding of teacher competencies, drawing from established methodologies in educational research (Saro et al., 2023).

The participants were 39 Grade 10 science teachers from all public secondary schools in the Division of Tanjay City, Negros Oriental, during the third quarter of School Year 2024–2025. Of these, 13 were male and 26 were female, with varied professional ranks ranging from Teacher I to Master Teacher II. A purposive sampling technique was employed to ensure that all participants had relevant teaching experience in Grade 10 Biology. Teachers were selected based on key variables such as the number of years they had been teaching science (categorized as 0–10 years and 11+ years) and their educational attainment (bachelor's degree, with MA units, or full master's degree). This sampling method ensured the inclusion of teachers whose experience and qualifications aligned with the goals of the study.

Two main instruments were used to gather data. The first was a researcher-developed Biology Content Knowledge Test, consisting of 27 multiple-choice items aligned with the Grade 10 science curriculum for the third grading period. Topics included the reproductive system, hormonal regulation, feedback mechanisms, genetic processes, evolutionary theory, and ecological concepts such as biodiversity and carrying capacity. The test was validated by 10 science education experts and yielded a Kuder-Richardson Formula 20 (KR-20) reliability score of 0.71, indicating acceptable internal consistency.

The second instrument was a Pedagogical Competence Questionnaire, adapted from Refugio et al. (2024) and designed to assess three dimensions of pedagogical skill: discipline (classroom management), teaching and learning (instructional strategies), and personal (student-teacher interaction). Items were rated on a five-point Likert scale, where 5 meant "Always Practiced" (100%) and 1 indicated "Not Practiced" (0%). The instrument underwent expert validation and achieved a high internal consistency with a Cronbach's alpha of 0.83. These tools were accompanied

by a demographic data sheet that collected information on the teachers' educational background and teaching experience.

Both instruments were subjected to rigorous validation and reliability testing. The content validity index (CVI) for the Biology test was 1.00, while the pedagogical competence tool had a CVI of 0.99. Face validity, measured using the Good and Scates method, yielded a score of 4.76, further supporting the appropriateness of the instruments for academic research.

Data collection was carried out online using Google Forms to ensure accessibility and minimal disruption to classroom routines. Cluster heads and school coordinators assisted in distributing the survey link. Participation was voluntary, and responses were collected over a two-week period. Ethical considerations were carefully observed, including informed consent, respondent anonymity, data confidentiality, and compliance with the Data Privacy Act of 2012. All data were securely stored and used exclusively for research purposes.

Quantitative data were analyzed using SPSS Version 23.0. Descriptive statistics such as means and standard deviations were used to determine the levels of content knowledge and pedagogical competence. Group comparisons were analyzed using the Mann-Whitney U test for teaching experience and the Kruskal-Wallis test for educational attainment. To determine the relationship between content and pedagogical competence, Spearman's rank correlation coefficient was used. Competence levels were interpreted using a researcher-developed scale, where scores of 4.20–5.00 indicated high competence and 1.00–1.79 indicated no competence. Correlation coefficients were interpreted using standard thresholds, with 0.00–0.20 indicating negligible correlation and 0.91–1.00 indicating a very high correlation. A 5% significance level ( $\alpha = 0.05$ ) was used in all inferential tests.

## **Results:**

The study aimed to evaluate the content knowledge and pedagogical competence in Biology among Grade 10 science teachers in the Division of Tanjay City. The findings are presented based on the research questions and are organized thematically to reflect group comparisons and correlations.

Results revealed that the teachers generally demonstrated high levels of content knowledge in Biology. The overall mean score for content competence was 23.97 (SD = 3.07), which fell within the "high competence" category. When grouped by teaching experience, teachers with longer service (more than 10 years) obtained a slightly higher mean score of 24.35 compared to 22.90 for those with shorter experience. Similarly, based on educational attainment, teachers holding a master's degree achieved the highest mean score of 26.67, compared to 23.84 for those with MA units and 23.55 for those with only a bachelor's degree. Despite these observed differences, statistical tests showed no significant differences in content knowledge when grouped by experience ( $p = 0.106$ ) or educational attainment ( $p = 0.161$ ), suggesting that these demographic variables did not significantly influence content competence.

In terms of pedagogical competence, the results also indicated overall favorable outcomes. Teachers were rated as "above average competent" with a group mean of 3.90 (SD = 0.65). Among the three measured dimensions, the personal dimension yielded the highest mean score of 4.12 (SD = 0.76), followed by teaching and learning ( $M = 3.97$ , SD = 0.69), and discipline ( $M = 3.50$ , SD = 0.76). This suggests that while teachers were generally effective in building relationships and delivering instruction, classroom management could be an area for improvement.

When pedagogical competence was analyzed according to years of teaching experience, those with longer experience ( $M = 4.12$ ) scored higher than those with less experience ( $M = 3.82$ ). With respect to educational attainment, teachers with MA units scored highest ( $M = 4.21$ ), followed by bachelor's degree holders ( $M = 4.00$ ), and full MA holders ( $M = 3.68$ ). Despite these variations, the Mann-Whitney U and Kruskal-Wallis tests both showed no significant differences in pedagogical competence when grouped by teaching experience ( $p = 0.182$ ) or educational attainment ( $p = 0.251$ ). These findings suggest that professional growth and effectiveness in pedagogy may not be solely determined by tenure or academic degree.

To explore the relationship between content knowledge and pedagogical competence, Spearman's rank correlation coefficient was used. The result showed a weak, negative, and statistically insignificant correlation ( $\rho = -0.269$ ,  $p = 0.098$ ). This indicates that higher content knowledge does not necessarily predict higher pedagogical competence, and vice versa. The two domains appear to function independently, reinforcing the notion that excellence in teaching requires targeted development in both content and pedagogy rather than relying on one to enhance the other.

The findings emphasize the need for professional development programs that simultaneously address content mastery and pedagogical enhancement. The weak correlation and non-significant group differences suggest that teachers' competence is influenced by factors beyond experience and education—such as engagement in continuous learning, reflective practices, and access to meaningful training opportunities.

### **Discussion:**

This study examined the content knowledge and pedagogical competence of Grade 10 science teachers in the Division of Tanjay City, and whether these competencies were influenced by teaching experience, educational attainment, or interrelated. The findings offer critical insights into the current landscape of science teacher preparation and underscore the importance of targeted, evidence-based professional development interventions.

The analysis showed that the majority of teachers possessed high content knowledge in Biology, regardless of their years of teaching or educational qualifications. While those with a master's degree had slightly higher mean scores, the lack of statistically significant differences suggests that formal credentials or teaching tenure are not sufficient indicators of disciplinary competence. These results align with Gamayao and Biñas (2021) and Kraft and Lyon (2024), who note that content mastery is often sustained through continuous engagement with updated science content, rather than accumulated experience alone.

In terms of pedagogical competence, teachers demonstrated an above average level, with notable strength in the personal and instructional dimensions, including student engagement and reflective teaching practices. However, the discipline dimension—relating to classroom management—received comparatively lower scores, indicating an area that requires professional support. Montana (2024) similarly observed that even accomplished teachers in science often lack confidence in managing student behavior during hands-on or inquiry-based activities.

Interestingly, the study found no significant differences in pedagogical competence based on years of teaching or educational attainment. This supports the work of Fernandes et al. (2023), who argue that pedagogical skill does not develop automatically with experience, but rather through structured and reflective professional learning. More critically, the study identified a weak and statistically insignificant correlation between content knowledge and pedagogical competence, suggesting that mastery in one domain does not guarantee strength in the other. These findings reinforce the position of Michel et al. (2025) and Sato and Kim (2023) that content and pedagogy are distinct yet complementary dimensions of teacher competence, both of which must be developed intentionally and concurrently.

This distinction is also affirmed by the study's theoretical underpinnings. Kolb's Experiential Learning Theory (ELT) provides a framework for designing professional learning that is iterative, reflective, and grounded in real teaching contexts. Burch's Conscious Competence Theory (CCT), on the other hand, highlights the psychological progression from unawareness of incompetence to automatic mastery—emphasizing the need for diagnostic feedback and differentiated training interventions tailored to a teacher's developmental stage.

These insights inform the proposed enhancement program, *SPECTRA: Strengthening Pedagogical and Content Teaching in Relevant Applications*. Designed in direct response to the study's findings, *SPECTRA* offers an integrated professional development framework that addresses both knowledge acquisition and pedagogical refinement. By embedding Kolb's reflective learning cycle into its structure and guiding teachers along the Burch competence ladder, the program aims to advance educators toward unconscious competence in both content and classroom practice. Sessions on instructional design, peer teaching, classroom management, and higher-order thinking skills are complemented by content deepening activities and reflective action planning—ensuring balanced development across domains.

*SPECTRA* also operationalizes recommendations from the literature on effective professional learning. It embraces approaches such as collaborative lesson planning, hands-on simulations, mentorship, and peer feedback, which are championed in models like professional learning communities (PLCs) and lesson study (Botha & Nel, 2022; Antinluoma et al., 2021). Importantly, the program also emphasizes assessment-driven development, whereby teachers' training needs are identified based on actual performance data—rather than assumed through rank or qualification.

The findings of this study therefore advocate for a shift in professional development philosophy: from one-size-fits-all training to responsive, competency-based interventions like *SPECTRA*. Especially in science education, where teachers must facilitate complex conceptual learning in dynamic classroom settings, such holistic and research-informed programs are essential to improving teacher efficacy and student achievement.

### **Conclusion:**

This study concludes that Grade 10 science teachers in the Division of Tanjay City generally exhibit high content knowledge in Biology and above average pedagogical competence, with strengths in instructional strategies and professional disposition. Despite these encouraging results, the data reveal that teaching experience and educational attainment do not significantly influence either content or pedagogical competence. Furthermore, the absence of a statistically significant correlation between the two domains suggests that mastery of subject matter does not automatically translate to effective teaching, and vice versa.

These findings affirm the necessity of targeted and integrated professional development programs. Rather than assuming that tenure or academic degrees equate to competence, professional growth must be rooted in structured support that simultaneously enhances what teachers know (content) and how they teach it (pedagogy). Theories such as Kolb's Experiential Learning Cycle and Burch's Conscious Competence Model offer valuable frameworks for designing such programs, as they emphasize reflective practice and progressive skill acquisition.

Ultimately, the effectiveness of science education depends on teachers who are not only knowledgeable in their field but are also equipped to translate that knowledge into engaging, inclusive, and learner-centered instruction. By recognizing the distinct nature of content and pedagogical competence, education stakeholders can design enhancement programs that develop both capacities—ensuring that every student has access to meaningful and high-quality science learning experiences.

### **References:**

- Adeoye, M. A., Prastikawati, E. F., & Abimbowo, Y. O. (2024). Empowering learning: Pedagogical strategies for advancing 21st century skills and quality education. *Journal of Nonformal Education*, 10(1), 10–21. <https://doi.org/10.15294/jone.v10i1.1451>
- Antinluoma, M., Ilomäki, L., & Toom, A. (2021). Practices of professional learning communities. *Frontiers in Education*, 6. <https://doi.org/10.3389/educ.2021.617613>
- Benson, O., Nwagbo, C., Christian, S., & Okeke, C. (2020). Students' Perception of Teachers' Pedagogical Skills and its Influence on their Attitude towards Science, Implication for Science, Technology and Engineering Careers. *International Journal of Mechanical and Production Engineering Research and Development*, 10(3), 14701–14714. <https://doi.org/10.24247/ijmpredjun20201397>
- Botha, C., & Nel, C. (2022). Purposeful collaboration through professional learning communities: Teacher educators' challenges. *International Journal of Learning, Teaching and Educational Research*, 21(6), 210–225. <https://doi.org/10.26803/ijlter.21.6.13>
- Burch, G. F., Burch, J. J., Bradley, T. P., & Heller, N. A. (2014). Identifying and overcoming threshold concepts and conceptions. *Journal of Management Education*, 39(4), 476–496. <https://doi.org/10.1177/1052562914562961>
- Cudal, I. G., Tabalba, C. M., & Paglinawan, J. (2024). Science Resources Availability and Teachers' Effectiveness. *International Journal of All Research Writings*, 6(6), 1–7.
- Department of Education. (2019). Policy Guidelines on the K to 12 Basic Education Program. In *Department Orders* (Issue 021, pp. 1–153). Department of Education. [https://www.deped.gov.ph/wp-content/uploads/2019/08/DO\\_s2019\\_021.pdf](https://www.deped.gov.ph/wp-content/uploads/2019/08/DO_s2019_021.pdf)
- Fernandes, S., Araújo, A. M., Miguel, I., & Abelha, M. (2023). Teacher professional development in higher education: The impact of pedagogical training perceived by teachers. *Education Sciences*, 13(3), 309. <https://doi.org/10.3390/educsci13030309>

- Gamayao1, M., & Biñas Jr., E. (2021). Teaching Competence and Pedagogical Content Knowledge of Science Teachers in the First District Of Capiz, Philippines: Basis for a Sustainable Instructional Program. *European Journal of Humanities and Educational Advancements (EJHEA)*, 2(1), 26–33.
- Hinampas, R., & Fajardo, M. teresa. (2024). Pedagogical Content Knowledge Studies in the Context of Chemistry Education in the Philippines: A Meta-Analysis. *Science International*, 36(2), 163–171.
- Hume, A., Cooper, R., & Borowski, A. (2019). *Repositioning pedagogical content knowledge in teachers' knowledge for teaching science*. Springer.
- Kraft, M. A., & Lyon, M. A. (2024). The rise and fall of the teaching profession: Prestige, interest, preparation, and satisfaction over the last half century. *American Educational Research Journal*, 61(6), 1192–1236. <https://doi.org/10.3102/00028312241276856>
- McCarthy, M. (2016). Experiential learning theory: from theory to practice. *Journal of Business & Economics Research (JBBER)*, 14(3), 91–100. <https://doi.org/10.19030/jber.v14i3.9749>
- Michel, M., Atkinson, D., Ribeiro, A. C., Alexopoulou, T., Cappellini, M., Eskildsen, S. W., Gao, X. (Andy), Hellermann, J., Kayi-Aydar, H., Lowie, W., Mejía-Laguna, J. A., Ortega, L., Pekarek Doehler, S., Sasaki, M., Sato, M., Thorne, S. L., & Zheng, Y. (2025). Forging common ground in second language acquisition and teaching: A combined synergy statement. *The Modern Language Journal*, 109(S1), 90–103. <https://doi.org/10.1111/modl.12983>
- Montana, J. (2024). School Head's Supervisory Skills, Performance of Teachers and Academic Performance of Students in General Biology. *International Journal of Advanced Multidisciplinary Studies*, 4(7), 134–148.
- Peterson, K., & Kolb, D. A. (2017). *How you learn is how you live: Using nine ways of learning to transform your life*. National Geographic Books.
- Saro, J. M., Apat, J. Q., & Pareja, M. S. (2023). A descriptive-correlational study of the teachers' motivation, competences, and perceptions in writing action research. *Journal of Advances in Education and Philosophy*, 7(1), 14–24. <https://doi.org/10.36348/jaep.2023.v07i01.003>
- Schwartz, M. S., Sadler, P. M., Sonnert, G., & Tai, R. H. (2008). Depth versus breadth: How content coverage in high school science courses relates to later success in college science coursework. *Science Education*, 93(5), 798–826. <https://doi.org/10.1002/sce.20328>
- Tapia, R., Fernández, I., Bobo-Pinilla, J., & Delgado-Iglesias, J. (2023). Teaching digestive system: Spanish pre-service teacher's learning difficulties and alternative conceptions. *Eurasia Journal of Mathematics, Science and Technology Education*, 19(4), em2244. <https://doi.org/10.29333/ejmste/13037>
- Welter, V. D. E., Herzog, S., Harms, U., Steffensky, M., & Großschedl, J. (2021). School subjects' synergy and teacher knowledge: Do biology and chemistry teachers benefit equally from their second subject? *Journal of Research in Science Teaching*, 59(2), 285–326. <https://doi.org/10.1002/tea.21728>