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Teaching Philosophies and Effective Instruction in Science Higher Education: Evidence From Structural Equation Modeling

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Abstract — This study investigated the structural relationship between teaching philosophies, instructional effectiveness among science educators in a state-run higher education institution and the importance of continuous professional development programs that strengthen pedagogical innovation, reflective teaching, and inquiry-oriented instruction among science educators. Utilizing a quantitative correlational design with Structural Equation Modeling (SEM), data were gathered from 73 science faculty members at President Ramon Magsaysay State University (PRMSU). The research employed the Teaching Philosophy Inventory and the Instructional Effectiveness Scale. Results indicated that while traditional philosophies remain present, progressivist and constructivist orientations predominate among modern science educators. The SEM analysis revealed that teaching philosophy significantly predicts effective instruction, with "student-centeredness" acting as the strongest latent construct. The model demonstrated a good fit, suggesting that an educator's philosophical foundation is a critical determinant of pedagogical quality. Recommendations include the integration of philosophical reflexivity in faculty development programs to enhance STEM outcomes.

Keywords: Teaching Philosophies, Effective Instruction, Science Education, Structural Equation Modeling

I. INTRODUCTION

The landscape of higher education in the sciences is undergoing a paradigm shift, transitioning from the "sage on the stage" model to more collaborative, inquiry-based frameworks. At the core of this transition lies the teacher's philosophy a set of deeply held beliefs about the nature of knowledge and the role of the educator. According to Hattie (2023), the "visible learning" effect is most pronounced when teachers view themselves as evaluators of their own effects, a mindset rooted in specific philosophical orientations.

In the Philippine context, the Commission on Higher Education (CHED) has advocated for Outcomes-Based Education (OBE), which necessitates a shift toward learner-centered philosophies (CHED, 2022). However, the alignment between what teachers believe (philosophy) and what they do (instruction) often remains decoupled. Recent studies suggest that science educators often struggle to reconcile traditional content-heavy curricula with the need for critical thinking and experimental inquiry (Darling-Hammond et al., 2020).

Despite the abundance of literature on pedagogy, there is a dearth of empirical evidence using advanced multivariate techniques like Structural Equation Modeling (SEM) to map the causal pathways between philosophical leanings and instructional outcomes in local state universities. This study fills that gap by examining these dynamics within President Ramon Magsaysay State University (PRMSU).

Statement of the Problem

This study aimed to determine the influence of teaching philosophies on effective instruction among science faculty at PRMSU. Specifically, it sought to answer the following:

1. What is the demographic profile of the science faculty in terms of:
   1.1 Gender;
   1.2 Educational Attainment; and
   1.3 Years in Service?
2. What are the dominant teaching philosophies (Essentialism, Perennialism, Progressivism, and Existentialism) among the respondents?

3. What is the level of instructional effectiveness in terms of pedagogical knowledge, student engagement, and assessment strategies?
4. Is there a significant relationship between teaching philosophies and effective instruction?
5. Does the proposed structural model effectively explain the relationship between teaching philosophy and instructional effectiveness?
6. Based on the validated structural model, what strategic intervention framework can be developed to optimize instructional effectiveness in science higher education?

II. METHODOLOGY

Research Design

The study utilized a quantitative explanatory research design utilizing Structural Equation Modeling (SEM) to examine the relationship between teaching philosophies and effective instruction among science faculty members of President Ramon Magsaysay State University. The design was selected because the study sought to explain the predictive and causal relationships between teaching philosophies as the exogenous latent construct and instructional effectiveness as the endogenous latent construct.

Research Locale and Participants

The study was conducted at President Ramon Magsaysay State University (PRMSU), specifically across its campuses offering science-related programs. The participants consisted of 73 science teachers selected through purposive sampling. Criteria for inclusion required that the participants were regular faculty members teaching Natural Sciences, Biological Sciences, or Physical Sciences during the Academic Year 2025–2026.

Research Instrument

The study utilized a two-part composite questionnaire designed to measure philosophical orientations and pedagogical performance. The first component comprised the

Philosophy of Education Scale (PES), adapted from the established framework of Ornstein (1991). This scale was employed to evaluate four distinct philosophical domains: Perennialism, Essentialism, Progressivism, and Existentialism. The second component consisted of the Instructional Effectiveness Scale (IES), a 5-point Likert-type instrument designed to measure three latent variables: Pedagogical Skill, Classroom Management, and Assessment Competence. To ensure the reliability of the research tool, the instrument underwent Cronbach's Alpha testing, which yielded a high reliability coefficient of $\alpha = 0.89$. This value indicates superior internal consistency and confirms the instrument's suitability for sophisticated multivariate analysis and structural modeling.

Data Collection and Procedure

The study implemented a dual-modal "hybrid" distribution strategy to maximize response rates and ensure data integrity across university campuses. For faculty situated at the main campus, printed instruments were hand-delivered. Conversely, a digital survey via Google Forms was utilized to facilitate seamless data entry and real-time validation for science faculty in the satellite campuses. This data collection phase was conducted over four weeks. Before participation, all respondents underwent a comprehensive briefing regarding the research objectives. To mitigate social desirability bias and ensure objective responses, participants were formally assured of their anonymity and provided with a guarantee that their data would remain strictly confidential and would have no bearing on their professional performance evaluations.

Data Analysis (Statistical Treatment)

The data were subjected to a comprehensive analytical process involving both descriptive and inferential methods. Descriptive statistics, including frequency distributions, percentages, and weighted means, were utilized to characterize the demographic profile of the participants and to assess the prevalence of dominant teaching philosophies. The reliability of the research instrument was rigorously verified using Cronbach's Alpha, ensuring high internal consistency across all scales. To explore the foundational associations between the primary variables, the Pearson Product-Moment Correlation *(r)* was calculated to determine the initial bivariate relationships.

Finally, Partial Least Squares Structural Equation Modeling (PLS-SEM) served as the core inferential framework to test the structural paths and evaluate the overall predictive power of the model. This method was specifically selected for its robustness and suitability in handling the study's specific sample size of N=73, allowing for a sophisticated analysis of the latent constructs involved in science higher education.

III. RESULTS AND DISCUSSION

Demographic Profile of the Respondents

The profile of the 73 science teachers at PRMSU reflects a highly qualified and experienced faculty. In Table 1, the gender distribution is nearly equal, suggesting a balanced representation of perspectives in the science department. Notably, 100% of the faculty possess graduate-level degrees, with 38.4% having attained a Doctorate. This high level of academic preparation correlates with the "Very High" pedagogical knowledge scores found in SOP 3. Furthermore, the majority of the faculty (48.0%) have been in service for 6–10 years, indicating a group that is past the "novice" stage and is likely in their peak professional growth period. The profile suggests that PRMSU science faculty are largely in the "mid-career" stage. Research by Huberman (1989) on the teacher career cycle suggests that educators in the 6-to-15-year range are typically in a phase of "experimentation" and "reaching out," where they are most open to pedagogical innovation and philosophical reflexivity. This professional maturity explains why the faculty shows a strong preference for Progressivism; they have moved past the survival stage of early teaching and are now focused on refining their instructional impact.

TABLE 1
DEMOGRAPHIC PROFILE OF THE RESPONDENTS (N=73)

Variables	Frequency (f)	Percentage (%)
Gender		
Female	36	49.3%
Male	37	50.7%
Educational Attainment		
Doctorate Degree	28	38.4%
Master's Degree	45	61.6%
Years in Service		
0–5 years	12	16.4%
6–10 years	35	48.0%
11–15 years	18	24.7%
16 years and above	8	10.9%
Total	**73**	**100%**

Dominant Teaching Philosophies

TABLE 2
MEAN SCORES OF TEACHING PHILOSOPHIES
AMONG PRMSU SCIENCE FACULTY

Philosophy	Mean ($\bar{x}$)	SD	Verbal Interpretation	Rank
Progressivism	4.42	0.45	Highly Dominant	1
Existentialism	4.15	0.52	Dominant	2
Essentialism	3.20	0.68	Moderately Dominant	3
Perennialism	2.85	0.74	Moderately Dominant	4

Table 2 reveals that Progressivism ranks first ($\bar{x} = 4.42$), interpreted as "Highly Dominant," followed by Existentialism ($\bar{x} = 4.15$) as "Dominant." Conversely, teacher-centered philosophies such as Essentialism ($\bar{x} = 3.20$) and Perennialism ($\bar{x} = 2.85$) are only "Moderately Dominant." This profile indicates that science faculty at PRMSU have moved away from traditional, lecture-heavy paradigms toward student-centered, inquiry-based frameworks.

The high dominance of Progressivism suggests that science educators prioritize experiential learning and problem-solving. This aligns with the findings of Dewey (1938), who argued that education must be grounded in real-world experience to be meaningful. In the context of science higher education, this preference supports the transition toward Outcomes-Based Education (OBE), where the focus shifts from content delivery to the development of competencies (CHED, 2022).

The second-rank position of Existentialism reflects a strong value placed on student agency and individual discovery. This is consistent with the views of Sartre (1946) regarding personal responsibility in learning. Modern literature suggests that when science teachers adopt existentialist leanings, they foster "epistemic agency," allowing students to take ownership of their scientific inquiries (Miller et al., 2018).

Furthermore, the moderate scores for Essentialism and Perennialism suggest a professional rejection of rigid, top-down instruction. According to Darling-Hammond et al. (2020), effective 21st-century instruction requires a "whole-child" approach that transcends the rote memorization typical of perennialist views. The faculty's preference for progressivist-existentialist orientations indicates a readiness to implement innovative pedagogical strategies such as flipped classrooms and virtual laboratories, which are essential for developing Higher-Order Thinking Skills (HOTS) in STEM disciplines.

Level of Instructional Effectiveness

TABLE 3
LEVEL OF INSTRUCTIONAL EFFECTIVENESS IN SCIENCE EDUCATION

Indicators	Mean ($\bar{x}$)	SD	Verbal Interpretation
1. Pedagogical Knowledge	4.51	0.38	Very High
2. Student Engagement	4.38	0.42	High
3. Assessment Strategies	4.25	0.50	High

Table 3 demonstrates a high level of instructional competence among the science faculty, with an overall emphasis on content delivery and student interaction. Pedagogical Knowledge ($\bar{x}$ = 4.51) emerged with the highest rating, interpreted as "Very High," while Student Engagement ($\bar{x}$ = 4.38) and Assessment Strategies ($\bar{x}$ = 4.25) were both interpreted as "High."

The "Very High" rating in Pedagogical Knowledge indicates that the faculty possesses a deep mastery of science content and the specialized methods required to teach it. This is supported by Shulman's (1987) construct of Pedagogical Content Knowledge (PCK), which posits that effective teachers do not just know their subject; they know how to make it comprehensible to others. The high academic qualifications of the respondents (with 100% holding graduate degrees) likely contribute to this proficiency, as advanced studies refine an educator's ability to synthesize complex scientific theories for classroom delivery (Hattie, 2023).

Student Engagement ($\bar{x}$ = 4.38) also scored highly, reflecting the faculty's success in creating an interactive learning environment. According to Kahu and Nelson (2018), student engagement is a critical mediator between teaching and learning outcomes; when teachers employ active learning strategies, student persistence in STEM fields increases. This high score suggests that the PRMSU faculty is successfully implementing the progressivist philosophies identified in the previous section by involving students in the learning process.

While still rated as "High," Assessment Strategies ($\bar{x}$ = 4.25) received the lowest mean among the three indicators. This minor disparity often occurs in higher education, where the shift from traditional testing to authentic, performance-based assessment requires continuous training

(Wiliam, 2018). Nevertheless, the overall results suggest that the faculty is highly effective in executing the core components of modern instruction, ensuring that scientific concepts are not only taught but are actively engaged with and assessed.

Relationship Between Teaching Philosophies and Instructional Effectiveness

TABLE 4
CORRELATION MATRIX BETWEEN TEACHING PHILOSOPHIES AND INSTRUCTIONAL EFFECTIVENESS

Variable	1	2	3	4	5
1. Progressivism	1.00				
2. Existentialism	.52**	1.00			
3. Essentialism	-.21	-.15	1.00		
4. Perennialism	-.30*	-.12	.48**	1.00	
5. Instructional Effectiveness	**.61****	**.48****	.12	.08	1.00

p < .05; **p < .01

The correlation matrix illustrates the interrelationships between teaching philosophies and their association with instructional effectiveness. A strong, positive, and significant correlation was found between Progressivism and Instructional Effectiveness *(r = .61, p < .01)*, as well as between Existentialism and Instructional Effectiveness *(r = .48, p < .01)*. Conversely, traditional philosophies like Essentialism *(r = .12)* and Perennialism *(r = .08)* showed no significant statistical relationship with teaching quality.

The significant correlation between Progressivism and Instructional Effectiveness confirms that a student-centered approach is a primary driver of pedagogical success in the sciences. This finding is consistent with Hattie's (2023) meta-analysis, which emphasizes that "reciprocal teaching" and "problem-solving" strategies consistently yield higher effect sizes in student achievement compared to passive instruction. This suggests that at PRMSU, the teachers move away from being "information providers" toward being "learning facilitators," and their perceived effectiveness increases.

The positive association with Existentialism underscores the importance of fostering student autonomy and personal relevance in STEM education. As noted by Biesta (2021), the "subjectification" of the student is a sign of advanced instructional quality. This correlates with modern science education trends that favor "epistemic agency," where students are treated as active creators of knowledge rather than mere consumers (Miller et al., 2018).

Interestingly, the negative or non-significant correlations with Essentialism and Perennialism reflect a growing "mismatch" between traditionalist beliefs and the demands of 21st-century science curricula. While these philosophies prioritize authority and fixed truths, Darling-Hammond et al. (2020) argue that rigid instructional styles often stifle the critical thinking and flexibility required in modern laboratory settings. These results provide a robust empirical foundation for the subsequent Structural Equation Modeling (SEM) analysis, confirming that the path toward effective science instruction at the university level is paved with student-centered philosophical beliefs.

Structural Model of Teaching Philosophy and Effective Instruction

TABLE 5
STRUCTURAL MODEL RESULTS (PATH COEFFICIENTS AND SIGNIFICANCE)

Structural Path	Path Coefficient (β)	T-Statistics	P-Values	Result
Teaching Philosophy → Effective Instruction	0.642	5.124	0.000	Significant
Specific Factor Loadings:				
Progressivism ← TP	0.824	8.331	0.000	Significant
Existentialism ← TP	0.715	6.210	0.000	Significant

The structural model results demonstrate a significant and robust relationship between the latent constructs. The primary path from Teaching Philosophy (TP) to Effective Instruction (EI) yielded a path coefficient of $\beta = 0.642$ *($t = 5.124$, $p < .001$)*, indicating a strong predictive link. Furthermore, the measurement model identified Progressivism (loading = 0.824) and

Existentialism (loading = 0.715) as the most critical indicators defining a teacher's philosophical orientation.

The path coefficient of 0.642 serves as empirical evidence that an educator's philosophical framework is a primary determinant of their instructional quality. This suggests that for every unit increase in the adoption of modern, student-centered philosophies, there is a corresponding 64.2% increase in effective instruction. This finding aligns with Hair et al. (2021), who suggest that in PLS-SEM, path coefficients above 0.60 represent strong causal-predictive relationships in social science research. It confirms that at PRMSU, teaching excellence is not merely a product of technical skill, but is deeply rooted in the teacher's underlying belief system.

The high factor loading for Progressivism (0.824) indicates that this philosophy is the strongest contributor to the model. This reinforces the "learning by doing" mandate in science education. As noted by Inquiry-Based Learning (IBL) theorists, when teachers view science as a process of discovery rather than a body of facts, they are more likely to employ high-impact practices like laboratory simulations and open-ended experimentation (Furtak et al., 2012).

Moreover, the significant loading for Existentialism (0.715) suggests that effective science instruction in higher education requires a recognition of student individuality and choice. This supports the work of Zimmerman (2002) on self-regulated learning, which posits that instructional effectiveness is maximized when students are empowered to take personal responsibility for their knowledge construction. Collectively, the SEM results provide a mathematical validation for a "Philosophical-Pedagogical Link," suggesting that university-level science instruction is most effective when it is grounded in progressivist and existentialist orientations.

Project PHILO-SCIENCE

Project PHILO-SCIENCE (Philosophical Integration for Learning Outcomes in Science) is a faculty development intervention designed to synchronize the internal belief systems of educators with modern, inquiry-based science instruction.

The Project PHILO-SCIENCE directly addresses the findings of the SEM analysis. Since the structural model revealed that 41.2% of instructional effectiveness is explained by teaching

philosophy, the intervention focuses on the "root cause" rather than just the "symptoms" of teaching performance.

By prioritizing Philosophical Reflexivity, the university moves beyond standard skills training. As indicated by the high path coefficient (β = 0.642), when a teacher's mindset shifts from "knowledge transmitter" (Essentialism) to "learning facilitator" (Progressivism), their effectiveness in engaging students and managing modern science laboratories increases significantly. This framework ensures that the transition toward Outcomes-Based Education (OBE) is culturally and philosophically embedded in the faculty's identity.

TABLE 6
THE PHILOSOPHICAL-PEDAGOGICAL ALIGNMENT FRAMEWORK (PPAF)

Key Result Area (KRA)	Objectives	Strategies/ Activities	Target Participants	Expected Outcome
1. Philosophical Reflexivity	• To help faculty identify and refine their core teaching philosophies.	The Mirror Workshop • Self-assessment using the PES tool and reflective journaling on teaching values.	Science Faculty (All Departments)	Defined personal teaching philosophy statements aligned with PRMSU's mission.
2. Pedagogical Translation	• To convert Progressivist beliefs into specific classroom actions.	Inquiry-Based Labs • Training on POGIL (Process Oriented Guided Inquiry Learning) and the 5E Instructional Model.	Science Teachers & Lab Technicians	20% increase in student-led laboratory activities.
3. SEM-Driven Mentorship	• To pair traditional-leaning faculty with progressivist mentors.	Peer-Observation Circles • Mentorship based on the structural model's high-loading indicators.	Science Faculty	Improved mean scores in "Student Engagement" across all science courses.
4. Assessment Calibration	• To align assessment strategies with existentialist/student-centered views.	Beyond the Multiple Choice • Workshop on Authentic Assessment, Portfolios, and Capstone Project Rubrics.	Science Faculty	Implementation of diverse assessment tools that measure critical thinking.

IV. CONCLUSION

The empirical evidence generated through Structural Equation Modeling (SEM) leads to the conclusion that teaching philosophy is a definitive predictor of instructional effectiveness within science higher education. The science faculty at President Ramon Magsaysay State University (PRMSU) represents a professionally mature and academically advanced cohort whose pedagogical success is deeply rooted in student-centered belief systems. Specifically, the high dominance of Progressivism and Existentialism among the respondents indicates a significant shift away from traditional, teacher-led paradigms toward inquiry-based and experiential frameworks.

The structural model confirmed a strong, positive, and significant path from Teaching Philosophy to Effective Instruction, with the model explaining 41.2% of the variance in teaching quality. This suggests that pedagogical excellence in the sciences is not merely a technical competency but a philosophical one. Teachers who embrace a facilitator role and prioritize student agency are statistically more likely to demonstrate superior pedagogical skills, classroom management, and assessment competence. Ultimately, the study concludes that for science instruction to be truly effective in a modern university setting, it must be grounded in a philosophy that views the learner as an active participant in the scientific process.

V. RECOMMENDATION

In light of the findings, the following are the proposed recommendations:

1. The university administration should adopt the proposed Philosophical-Pedagogical Alignment Framework (PPAF). This faculty development intervention should move beyond traditional skills training and focus on "philosophical reflexivity," allowing educators to consciously align their internal belief systems with outcomes-based education (OBE) mandates.
2. Science departments should transition from "cookbook" laboratory manuals to open-ended, inquiry-based modules. This change directly supports the Progressivist and Existentialist leanings of the faculty, providing them with the curricular flexibility to maximize their instructional effectiveness.

3. Science faculty members are encouraged to continuously adopt and sustain student-centered pedagogical approaches that promote inquiry-based learning, experiential activities, and learner autonomy, consistent with their identified dominant teaching philosophies.

4. Future researchers are encouraged to expand the current SEM by including Student Learning Outcomes (SLO) as a third latent variable. This would allow for a more comprehensive "Philosophy-Instruction-Outcome" path analysis to determine how a teacher's mindset directly impacts student achievement and licensure examination performance in the sciences.

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