

# Causal Modeling to Explore the Correlations among Teachers' Competence, Teaching Strategies, and Student Learning Achievement in Science

Maureen Joy F. Postrado

Department of Education, Rangas Ramos National High School, San Jose, Camarines Sur, Philippines \*

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## ABSTRACT

The misalignment between the teaching process and expected outcomes of the K-12 curriculum guidelines, traditional teaching strategies, the unresolved problems in the science program and almost absence of teachers' competence are among the challenges of the education system. Rooted in theory of cognitivism, this perspective underscores the importance of understanding the teachers role in the students learning achievement, which could cause the Philippines to lag behind other countries in international assessment.

The study provides a concrete view of the relationship of teaching competence, teaching strategies and student learning achievement through Path analysis using SEM. The data were obtained through descriptive survey among 45 teachers and achievement test results of 450 students in Partido district. There were a total of five variations of methods used by the teachers to teach the science classes, and the dominance of traditional methods was observed. The occurrence of inadequately capacitated teachers in science, does not spell a bright prospect for science education in senior high school. These serious constraints deserve serious attention to pre-empt the situation from evolving into a critical educational concern.

The study also found a strong correlation between innovative teaching strategies such as interactive and experiential learning to teachers' competency. The path analysis through SEM avers that when teaching competence is combined with appropriate teaching strategies, it provides a mediation effect that enhance student learning achievement.

This paper suggests that for teachers to uphold and promote innovative teaching strategies, their competitiveness needs to be enhanced and their self-efficacy needs to be strengthened initially.

**Keywords:** Teaching Strategies, SEM, Student Achievement

## INTRODUCTION

The current performance of Filipino students in the recent international assessment (PISA, 2022) generated some questions on the quality of science teaching in senior high school. Although K-12 curriculum aimed to provide greater opportunities to students (Dizon et al, 2019), by offering students exposure to spiral projection approach wherein various areas were compressed and taught in every grading period (Sanchez, 2014). There are some misalignments between established learning pedagogies and the expected outcomes on the curriculum guidelines, revealing a mismatch between teachers' and students' perceptions and the set expectations of the country's K-12 program (Almerino et al., 2020; Santiago, 2022). Students also are

continually exposed to isolated data and lack essential ideas, which causes learning to become detached from their experiences and causes them to lose interest in the profound significance of science (Sulaiman et al., 2010). There is an established and growing body of literature highlighting the significance of teaching strategies in science for effective outcomes. (Yadeta and Asefa, 2017) These are significant educational practices, as is implementing an appropriate pedagogy, addresses students' learning requirements in pursuit of academic achievement, in which teachers have the most critical role in establishing an effective learning environment (Kyndt et al., 2016) Additionally, comprehensive and careful instruction planning and incorporating different strategies will eventually motivate students to seek deeper knowledge (Klassen and Tze, 2014)

However there are no studies have been conducted that examined how the competency of teachers using teaching strategies influence students' performance, which means that these issues remain unresolved. This paper aimed to examine the relationship between the student learning achievement, teachers' teaching competences, and teaching strategies of the science teachers in Partido; in order to generate more robust information that will enhance stakeholders to have deeper understanding on the issues concerning science teaching in senior high school and guide policies to address barrier that constraint the secondary education in providing quality instruction.

## LITERATURE REVIEW

The incorporation of common essential learning and the effective instructional approaches is essential in planning the lesson. It is critical for teachers to have a conceptual foundation for comprehending the stages of instructional decision-making (Regina, 2010).

It is critical to evaluate the efficacy of our existing teaching strategies and to develop novel approaches for the improvement of the teaching and learning process. Teachers have the obligation to establish a connection with students, understand their academic needs, and assist them in strengthening their enthusiasm to study. (Sulaiman et al., 2021). Teachers provide an impact in the classroom, depending on their capacity and ability to create an effective teaching strategies that will make a learning opportunities for their students.

Teachers must look for opportunities to expand their knowledge about how to support and guide students with a range of interests, skills, and experiences. Students may then be able to make sense of scientific concepts with greater clarity and provide applications in the actual setting (Berdoni, 2018).

Assessment is a necessary component of teaching since it involves making judgments based on surveys, observations, and analysis of processes and results (Ferretti, 2021). Learning achievement is proof of a student's success or their ability to complete learning tasks effectively. Students' comprehension develops as a result of teacher-student interactions that boost the growth of student knowledge, attitudes, and abilities. Students that have a high adversity quotient and flexibility grow more rapidly and are more likely to achieve (Nurhaidah, 2015).

However, basic education in the Philippines has suffered a major performance setback in recent years. The country's chances of fulfilling its commitment to Education for All movement and relevant Millennium Development Goals are unlikely unless the key determinants of these goals are identified, and policies must be reoriented toward improving the performance of these key determinants to arrest the declining trends in education outcomes (Maligalig et al., 2010).

The Philippines performs poorly on international assessments (TIMSS, 2018; PISA 2018), which raises serious concerns about the quality of science education. The effectiveness of teaching may have a negative

impact on student learning because of the close relationship that exists between students and their teachers. Competence, effectiveness, and a teacher’s sufficient content understanding are all indicators of quality (Galiza et al., 2018).

The low standing of the country in the PISA 2022 rankings for the second consecutive time serves as a stark indicator that the education system is currently in a dismal state, requiring extensive efforts of the various stakeholders for improvement. This subpar performance is not solely an issue within the education sector but reflects a broader national concern. Urgent attention, collaborative endeavors, and a dedicated commitment to enhancement are imperative to address the current state of education in the Philippines, ensuring a more optimal learning experience for our children (Malipot, 2023).

## METHODOLOGY

This study utilized the Descriptive Correlational Research Design. Total enumeration sampling were applied among the 45 SHS Earth and Life Science teachers and random sampling for 450 Grade 12 student-respondents; A total of 495 respondents from 20 public secondary schools of Partido District, Camarines Sur. Survey questionnaires among teachers and learning achievement test as evaluation tool for students were utilized as the data collection instruments. Correlational analysis was implemented to select variables with a high association with the outcome variable. While Structural Equation Modeling (SEM) were employed through a two-step process using the robust maximum likelihood estimator in examining the measurement of the variable and then the structural equation to generate a path model which present the direct or modulating effect of independent variables on students’ learning achievement (Raccanello et al., 2022).

## RESULTS

The teaching competencies were divided into two categories: competence in the pedagogical process (Table I) and competence in learning content (Table II).

For competence in the pedagogical process, the results show that teachers were Much Competent but five (5) of the indicators, or 38% of them, were posted as Competent, with the least average mean result of  $\mu=3.07$  ( $3.07=$ Competent) for the indicator on “Using research-verified strategies to address students with special needs,” and teachers were Much Competent among the 62% of the indicators, with the highest obtained average mean of  $\mu=3.89$  for the indicator on ” “Designing and teaching activities appropriate for learning objectives” shows an average mean of  $\mu=3.62$  posted as Much Competent, indicating that teachers in general have fair competency in the pedagogical process.

TABLE I TEACHING COMPETENCE IN PEDAGOGICAL PROCESS

	Indicators	VM	VI
1	Participating in the identification of areas that need to be addressed in the school improvement plan	3.22	C
2	Planning instruction depends on the different developmental levels of the students	3.37	C
3	Collaborating with colleagues to monitor student performance	3.85	MC
4	Cooperating with or inviting a specialist to support the special learning needs of the students	3.26	C
5	Designing activities that satisfy the curiosity of the students	3.70	MC
6	Designing and teaching activities appropriate for learning objectives	3.89	MC
7	Designing instructions responsive to cultural differences	3.26	C

8	Using research-verified strategies to address students with special needs	3.07	C
9	Eliciting students' participation by using appropriate questioning strategies	3.81	MC
10	Using scientific terms correctly (in terms of pronunciation and vocabulary)	3.67	MC
11	Using appropriate positioning in the classroom	3.59	MC
12	Managing the class in an enthusiastic manner	3.81	MC
13	Pacing the lesson according to the student's understanding and learning	3.70	MC
	Overall Average	3.55	MC

Legend: 1.0-1.79: Not At All; 1.80-2.59: Fairly Competent; 2.60-3.39: Competent; 3.40-4.19: Much Competent; 4.20-5.00: Highly Competent

For the Teaching Competence in the Learning Content.. Table II shows that 1 of the indicators were rated competent by the teachers, with the lowest average mean of  $\mu=3.41$  showed for the indicator on " Illustrating the process of homeostasis, salt and water balance, and waste removal"

While the remaining 95% of the indicators were rated as Much Competent with the highest average mean of  $\mu=4.26$ , exhibit for the indicator in "discussing the differentiation of biotic and abiotic ecosystem components". It implies that the teachers are Much Competent in terms of their capability in teaching the learning content, with an overall mean  $\mu=3.75$ .

TABLE II TEACHING COMPETENCE IN LEARNING CONTENT

	Indicators	Mean	VI
1			
2	Describing the subsystems of the Earth	4.04	MC
3	Explaining the current information on the solar system	3.89	MC
4	Classifying rocks	3.89	MC
5	Citing evidence of continental drift	3.63	MC
6	Exploring exogenic processes	3.52	MC
7	Describing the process of metamorphism	3.52	MC
8	Describing the stratification rocks	3.15	MC
9	Giving practical ways of coping with hydro-meteorological hazards	3.78	MC
10	Describing the coastal processes	3.44	MC
11	Explaining the evolving concept of life-based on emerging pieces of evidence	3.81	MC
12	Discussing the unifying themes of life	4.07	MC
13	Describing the classic experiments that model conditions which enabled the first forms to evolve	3.59	MC
14	Explaining how cells carry out functions required for life	4.04	MC
15	Describing how organisms obtain and utilize energy	4.00	MC
16	Identifying ways in animals reproduction	4.07	MC
17	Describing the process of genetic engineering	3.33	MC
18	Illustrating the process of homeostasis, salt and water balance, and waste removal.	3.41	C
19	Defining the natural selection and evolution	3.96	MC
20	Describing the evolutionary relationships and classification of organisms	3.59	MC

21	Explaining the factors that affect the organisms	3.78	MC
22	Identifying the impacts of human activities	4.26	MC
	Total	3.75	MC

Legend: 1.0-1.79: Not At All; 1.80-2.59: Fairly Competent; 2.60-3.39: Competent; 3.40-4.19: Much Competent; 4.20-5.00: Highly Competent

For the frequency of teaching strategies employed by the science teachers in Earth and Life Science subjects, in which multiple responses were considered as combination of strategies they were using in teaching Science.

As presented in Table III, the Direct Instruction obtained the highest frequency of 40, followed by Indirect Instruction (34), Independent Study (23), Interactive Learning (20), and the least is the Experiential Learning (17).

The results showed that Direct Instruction is the most common teaching strategy used by the Partido Science teachers. These indicate that despite the variability of teaching repertoires, there is a dominance of conventional teaching strategies among the teachers teaching earth and life sciences.

TABLE III THE FREQUENCY OF TEACHING STRATEGIES EMPLOYED BY THE TEACHERS

Teaching Strategy	F	Rank
Direct Instruction	40	1
Indirect instruction	34	2
Experiential Learning	17	5
Independent Study	23	3
Interactive Learning	20	4

Note: N=45

The SEM model for the modulating effect between teaching competence, teaching strategies, and student learning achievement presents in Figure 1.

Teaching competence affects student learning achievement with path coefficient estimates of 4.01 (direct effect). While teaching competence influences teaching strategies with path coefficient estimates of 0.45 (direct effect). Furthermore, because teaching competence influences teaching strategies, results depicted that student learning achievement has been largely affected, as indicated by the path coefficient estimates of 5.09. But when teaching competence modulates teaching strategies, the influence of teaching strategies on student learning achievement increases with path coefficient estimates of 1.80 as a modulating effect, meaning for every one unit of increase in teaching strategies there is a corresponding increase of 1.80 in student learning achievement.

Between the two factors, such as teaching strategies and teaching competence, the influence of teaching strategies is comparatively more profound than that of teaching competence. However, when the teaching competence of teachers is combined with appropriate teaching strategies, the teaching competence has a modulating effect on the teaching strategies, producing a synergistic effect that enhances student learning achievement.

This indicates that in order for the teaching strategies to effectively promote higher student learning achievement, the teachers must be competent enough to teach earth and life sciences.

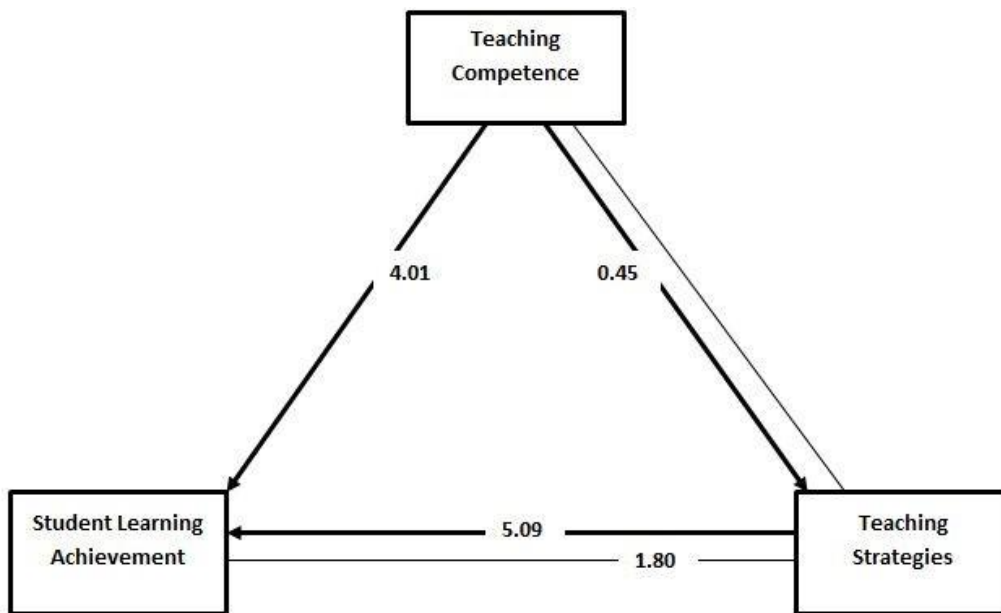


Figure 1: SEM for the Path Analysis between Teaching Competence, Teaching Strategies and Student Learning Achievement

## DISCUSSION

It is very much evident that the teacher respondents in general possess a fair level of competencies in pedagogy and depth of knowledge on the Science subject they are teaching for it promotes positive learning outcomes (Nie et al., 2013) and potentially influence both the kind of environment that they create as well as the various instructional practices introduced in the classroom (Eslami, 2018; Klassen and Tze, 2014).

Most of the earth and life science teachers on the study site are using a variety of methods to teach their classes. These variations in pedagogical strategies were identified to a total of 5. But despite these variations in teaching strategies, the dominance of indirect and direct variants indicates the existence of traditional teaching strategies in a subject that seems to require non-conventional teaching strategies such as experiential learning and interactive teaching strategies, which are necessary to cater to in-depth knowledge. These are supported by Mupa and Chinooneka (2015) finding that teachers are still textbook-based; small group activities are performed by students, but many teachers do not adequately process the results of these activities.

The occurrence of inadequately capacitated teachers in science, with low self-efficacy and using traditional teaching strategies as their dominant and common pedagogy, does not spell a bright prospect for science education in senior high school (Perera and John, 2020). These serious constraints deserve serious attention to preempt the situation from evolving into a critical educational concern.

The realization of this theory can take support and encouragement from the key findings of the study on the path analysis between teaching competence, teaching strategies, and learning achievement. These findings aver that for teaching strategies in earth and life sciences to effectively promote higher achievement, the teachers must be capacitated to become competent enough (Sulaiman et al., 2010). Between teaching strategies and teaching competency, as the two factors that influence student learning achievement, the

teaching strategies is comparatively more profound than the teaching competency. However, when teaching competency is combined with appropriate teaching strategies in science (such as experiential and independent learning), the teaching competency can provide the modulating effect on the teaching strategies to produce a synergy that enhances student learning.

## CONCLUSIONS

Most of the earth and life science teachers on the study site are using a variety of methods to teach their classes and general possess a fair level of competencies in pedagogy and depth of knowledge on the Science subject they are teaching for it promotes positive learning. The study found a strong correlation between strategies, teachers' competency, and the student learning achievement. This implies that teachers should have ongoing professional development to enhance teaching competence. While future researchers are encourage to conduct longitudinal studies to track the sustained impact of ongoing professional development in a wider scale or across regions to provide valuable insights for enhancing teaching practices and student outcomes.

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