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Leveraging Pre-service Science Teachers Competencies: Addressing the Demands of Glocal Educators

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Abstract
Educators must possess a dynamic blend of global awareness and local responsiveness to meet diverse learning needs, making the development of glocal competencies essential for inclusive and culturally relevant teaching. This study investigated the significant relationship and influence of preservice science teachers' competencies, self-regulation strategies, and instructional practices on course learning outcomes attainment. It also aimed to determine the best-fit model showing the interrelationships between and among variables. A quantitative descriptive correlation research design was employed in this study using a purposive sampling technique with a sample of 228 preservice science teachers among selected universities and colleges of Region XI. The study's findings revealed that the levels of preservice science teachers' competencies, self-regulation strategies, instructional practices, and attainment of course learning outcomes were all very high. There was a positive correlation and significant influence between preservice science teachers' competencies, self-regulation strategies, and instructional practices on course learning outcomes attainment. The best fit structural equation model yielded good results as indicated by goodness of fit indices. It was found that preservice science teachers' competencies, self-regulation strategies, and instructional practices significantly predict the attainment of preservice science teachers in the course learning outcomes attainment. It further recommended that teacher education programs focus on competent teachers who master specific skills and competencies, and revisit K-12 teacher training standards, ensuring alignment with CHED, DepEd, and PRC for quality education.

Keywords: Pre-service science teachers competencies, self-regulation strategies, instructional practices, course learning outcomes attainment, glocal educators, Philippines.

1. Introduction

Amid ever-changing educational aspects, preservice teachers must be equipped to adapt to teaching challenges. The report of EDCOM II (2023) revealed low content mastery and pedagogical competencies among teachers, highlighting a significant need for developing higher-order thinking skills. This issue is further underscored by the underperformance in teacher education licensure examinations, which show an average pass rate of only 33% for elementary and 40% for secondary levels from 2009 to 2023, substantially lower than the passing rates of other professional board exams.

Further, the 2022 "Program for International Student Assessment" (PISA) result showed that students in the Philippines remain among the world's weakest in math, reading, and science. As reported, 23% of students in the Philippines reached basic proficiency in science, which means that only one out of four Filipino students in PISA 2022 had the skills to recognize the correct explanation from familiar scientific phenomena (Chi, 2023). Similarly, in the 2019 "Trends in International Mathematics and Science Study" (TIMSS), the Philippines also came in last out of 58 countries in mathematics and science (Sison, 2022). The implication can be drawn from PISA and TIMSS results to address pre-service science teachers' competencies and teaching efficacy. Educational institutions can better prepare future educators to enhance student learning outcomes in science education.

Notably, various authors who have explored similar studies highlight the importance of a holistic approach to teacher education, emphasizing the need for a comprehensive understanding of the multifaceted factors influencing educational outcomes. Strong pedagogical skills, effective classroom management, and accurate assessment practices are crucial for effective teaching and positively impacting student learning outcomes (Shulman, 1987; Shing et al., 2015; Fauth et al., 2019; Krell et al., 2022). Moreover, self-regulation strategies such as goal setting, help-seeking, and managing the physical environment are associated with higher academic achievement and professional growth among teachers (Wandler & Imbriale, 2017; Stanton et al., 2020; Maharani & Darmawan, 2024). Additionally, well-planned lessons, active teaching practices, and constructive feedback significantly enhance student understanding and performance (Winters & Echeverri, 2012; Hofer, 2016; Shehab, 2019; Oslon et al., 2021).

Moreover, to strengthen the competencies of pre-service teachers, particularly in terms of pedagogical content knowledge and learning environment, CMO 104 s. 2017 revised and broadened the national guidelines for student internship programs in the Philippines, enhancing their quality and implementation (Espiritu, 2021). This established a framework for Higher Education Institutions and industry partners to prepare students for the workforce through collaborative, practical training.

Similarly, the study by Krell et al. (2020) in Australia mentioned that pre-service science teachers are tasked with developing scientific reasoning competencies as a crucial component of their professional training, as emphasized in science education policies and standards globally. Additionally, Ramirez (2021) suggests that pre-service teachers can effectively apply their theoretical knowledge of pedagogy and student diversity in their teaching practice.

Further, Lekhu (2023) pointed out that Initial Teacher Education (ITE) programs should adopt posthuman pedagogies that foster instructional strategies to bolster future teachers' confidence in scientific teaching efficacy beliefs. Also, Anam (2022) emphasized that effective science teaching requires strong content knowledge and robust pedagogical content knowledge (PCK) among pre-service teachers, emphasizing the importance of mastering subject-specific content knowledge (SCK). Mastering core subjects and 21st-century skills, including content knowledge, learning and innovation, information and media literacy, and life and career skills, is crucial for all students (Boholano et al., 2019).

Graduate capability and employability are seen as essential measures of success for degree programs by universities, industry, and students (Henderson & Trede, 2017). Highlighting the importance of inclusive and equitable assessments, aligning learning outcomes with institutional goals and accreditation requirements, and promoting continuous improvement in student learning through effective assessment practices (Kadappa et al., 2020; San Diego Miramar College, 2023). Furthermore, Olson (2021) pointed out various assessment methods, including rubrics, exams, projects, and portfolios, to evaluate student attainment of course outcomes (COs) or student learning outcomes (SLOs), emphasizing alignment with

course objectives, constructive feedback, and ongoing refinement for enhanced the learning outcomes of the students.

Despite extensive research on individual aspects such as teacher competencies, self–regulation strategies, or instructional practices, there remains a gap in understanding how these variables collectively impact student learning outcomes. Consequently, this recent study will fill in the gaps in teacher education programs by creating and validating a best-fit model that can be used for further research and practical application in teacher education.

This study, anchored with the Input-Environment-Output model proposed by Astin (1993), emphasizes the interdependence of student Inputs, Environment, and Outputs. This study will determine how pre-service teachers' competencies and self-regulation strategies serve as inputs, influencing their instructional practices and course learning outcomes as outputs. Also, the Self-Efficacy Theory, which was developed by Albert Bandura (1977), asserts that individuals' belief in their ability to perform a task influences their motivation and performance. In the perspectives of this study, the pre-service science teachers' self-efficacy can be linked to their self-regulation strategies, instructional practices, and competencies. The TPACK model of Mishra and Koehler (2006) posits the importance of integrating technological, pedagogical, and content knowledge to enhance educational outcomes. In the discourse of this study, the TPACK model can be effectively utilized to assess and enhance how pre-service science teachers integrate technological tools (TK), pedagogical strategies (PK), and science content knowledge (CK) in their teaching. The Self- Determination Theory developed by Deci and Ryan (2019) emphasizes the innate growth tendencies of individuals, and when the three core psychological needs: autonomy, competence, and relatedness fulfilled, each is more likely to experience intrinsic motivation, leading to behaviors driven by internal satisfaction, enhance teaching practices and ultimately contribute to improved student learning outcomes attainment (Stanton et al., 2020). The study will examine how meeting the needs for autonomy, competence, and relatedness influences pre-service teachers' motivation and effectiveness. The Danielson Framework for Teaching, developed by Charlotte Danielson, provides a comprehensive model categorizing teaching responsibilities into four domains: planning and preparation, the classroom environment, instruction, and professional responsibilities, as a valuable tool for educators to improve instructional practices and ultimately enhance student learning outcomes (Danielson, 2009; Alvarez & Ketchmark, 2011). From the study's perspective, it will evaluate and enhance instructional planning and preparation, classroom environment, instruction, and professional responsibilities.

In this study, the first exogenous or independent variable is pre-service science teachers' competencies, which has five observed variables: pedagogical skills, classroom management skills, and student performance assessment skills, adapted from the work of Padagas (2018) and additional two observed variables based on the PPST competencies: content knowledge and digital literacy and technological skills. The second exogenous variable, self-regulation strategies, consists of five observed variables developed by Kocdar et al. (2018): goal setting, help-seeking, managing physical environment, and effort regulation. However, the additional indicator of emotional resilience was added as an alternative to self-study study strategies. Moreover, the third exogenous variable is instructional practices consisting of five observed variables based on the study of Francisco and Celon (2020), namely planning practices, teaching practices, and assessment practices, while project-based learning practices and AI and Robotics integration practices are added. Lastly, the endogenous or dependent variable is students' course learning outcomes attainment comprised of five observed variables as developed by Prentice and Robinson (2010): critical thinking,

communication, career and teamwork, global understanding and citizenship, academic development, and educational success.

This research study investigates the complex relationships of pre-service science teachers' competencies, self-regulation strategies, and instructional practices on course learning outcomes attainment. First, it seeks to determine the level of pre-service science teachers' competencies in terms of pedagogical skills, content knowledge, classroom management skills, student performance assessment skills, and digital literacy and technology skills. Second, it seeks to determine the level of self-regulation strategies in terms of goal setting, help-seeking, emotional resilience, managing the physical environment, and effort regulation. Third, it seeks to determine the level of instructional practices in terms of planning, teaching, assessment, project-based learning, and AI and Robotics integration practices. Fourth, it seeks to determine the level of attainment of course learning outcomes in terms of critical thinking, communication, career and teamwork, global understanding and citizenship, academic development, and educational success. Fifth, it assesses the significant relationship between exogenous and endogenous variables. Sixth, it evaluates the significant influence between exogenous and endogenous variables. Finally, it determines the best-fit model for interpreting structural interrelationship among pre-service science teachers' competencies, self-regulation strategies, instructional practices and course learning outcomes attainment.

2. Method

Research Respondent

A total of 228 pre-service science students from selected colleges and universities of Region XI were the respondents of the study. The respondents were informed about the purpose of the study and obtained Informed Consent Forms personally and online. According to Memon et al. (2020), Kline's guidelines suggest that a sample size of 200 is generally recommended for SEM, as it produced a reliable result in the study of Ali et al. (2021). As such, the researcher will also adhere to the aforesaid existing literature. In this study, the criteria of the respondents were: 1) enrolled from colleges and universities that offered BSED – Science major program; and 2) the respondents must have experience of practice teaching in the field covered within three consecutive semesters of SY 2023-2024 and first semester of SY 2024-2025.

Materials and Instrument

The researcher utilized a descriptive survey and maximized adapted questionnaires from various authors to fit the study's objectives. There were added indicators that aligned with the Philippine Professional Standards for Teachers guidelines in accordance with the Policies, Standards, and Guidelines of the teacher education program. The questionnaire is divided into five parts. Part 1 is the respondents' profile, including the institution type and name of the school, and the scaling and interpretation. Part 2 is the questionnaire adapted from the work of Padagas (2018) for pre-service science teachers' competencies, which comprises 25 items that assess the five main factors: pedagogical skills, content knowledge, classroom management skills, student performance assessment skills and digital literacy and technology skills with a Cronbach alpha coefficient of 0.885. Part 3 is the questionnaire for self-regulation strategies, adapted from Kocdar et al. (2018), which consists of 25 items to assess the five main factors: goal setting, help-seeking, emotional - resilience, managing physical environment, and effort regulation with a Cronbach alpha coefficient of 0.887. Part 4 is the adapted questionnaire of Francisco and Celon (2020) for instructional practices, which comprises 25 items to assess the five main factors: planning practices, teaching practices, assessment practices, project-based learning practices, and AI and robotics integration practices with

Cronbach alpha coefficient of the questionnaire of 0.822. Lastly, part 5 is adapted from the work of Prentice and Robinson (2010) for students' course learning outcomes attainment, which contains 25 items to assess five main factors: critical thinking, communication, career and teamwork, global understanding and citizenship, and academic development and educational success with Cronbach alpha coefficient of 0.856 which all belongs to good reliability range according to Zakariya (2022) and Bujang et al. (2018).

Design and Procedure

The study employed a quantitative, non-experimental, descriptive-correlation research design to determine each variable's significant relationship and influence. Furthermore, the Structural Equation Modeling (SEM) was maximized to find the best fit structural model of course learning outcomes attainment in the context of pre-service science teachers.

The respondents were asked to respond to the questionnaire items on a five-point Likert scale. Some respondents answered face to face, and others were online surveys developed through Google form with appended consent. The survey link was sent to the respondents via social media. The data obtained was bounded with confidentiality and privacy to fully protect the respondents' rights in compliance with the Data Privacy Act of 2012.

In analyzing the data, the Mean was used to describe the level of pre-service science teachers' competencies, self-regulation strategies, instructional practices, and course learning outcomes attainment. Pearson Product Moment Correlational was used to measure the significant relationships of pre-service science teachers' competencies, self-regulation strategies, and instructional practices on course learning outcome attainment. Multiple Regression Analysis was employed to assess the predictive power of the exogenous variables: pre-service science teachers' competencies, self-regulation strategies, and instructional practices on the students' course learning outcomes attainment. Lastly, the Structural Equation Model (SEM) was used to establish the best-fit model for attaining course learning outcomes for pre-service science teachers.

3. Results and Discussion

Level of Pre – service Science Teachers' Competencies

Table 1 shows an overall mean of 4.54, categorized as very high, with a variability of 0.26. This implies that pre-service science teachers' competencies are always demonstrated in their practice teaching. Among all indicators, student performance assessment skills had the highest mean value of 4.65, described as very high, which means that the PST competencies in student performance assessment skills are always demonstrated. This implies that pre-service science teachers always check students' understanding, processes, and products, systematically measure students' progress using appropriate assessment methods, provide timely feedback about students' performance, and consistently use authentic assessment tools like rubrics. The result is congruent with the study of Padagas (2018) that preservice science teachers must employ diverse assessment methods and feedback techniques, necessitating comprehensive training, including the use of rubrics to effectively evaluate students' work amid increasing emphasis on written tasks and performance evaluation. Also, the finding supported the ideas of Pappas (2023) that teachers must require the students to apply their knowledge, skills, and strategies by creating a response product that is judged against standards to measure the higher-order thinking skills of the learners.

On the other hand, content knowledge has the lowest mean value of 4.34, described as very high, which means that pre-service science teachers' competencies in terms of content knowledge are always demonstrated. This implies that pre-service science teachers always show confidence in their

understanding of the fundamental principles of Biology, Chemistry, and Physics and their professional education courses, apply science content knowledge to design experiments, address common misconceptions in some science concepts, and read scientific journals or articles to stay updated with the recent advancement of their field. The result supports the claim of Boholano et al. (2019) that modern educators must skillfully combine subject expertise, creative teaching approaches, and advocacy for student and professional needs. Additionally, the finding agreed with the ideas of Lekhu (2023) that preservice science teachers must have both strong content knowledge and an understanding of how to teach the content effectively. It also affirmed the study of Buma and Sibanda (2022) that skilled science teachers utilize their extensive knowledge to adapt content in lesson planning to enhance effective learning.

Table 1. Level of Pre-service Science Teachers' Competencies

Indicators	SD	Mean	Descriptive Level
Pedagogical Skills	0.60	4.59	Very High
Content Knowledge	0.41	4.34	Very High
Classroom Management Skills	0.32	4.54	Very High
Student Performance Assessment Skills	0.30	4.65	Very High
Digital Literacy and Technology Skills	0.38	4.48	Very High
Overall	**0.26**	**4.54**	**Very High**

Level of Self- regulation Strategies

Table 2 shows the overall mean of 4.55, which is described as very high, with a variability of 0.24. This implies that the self-regulation strategies of pre-service science teachers are always manifested. It indicates that the respondents have the skills to manage their learning effectively and adapt to challenges. Notably, among all indicators, effort regulation garnered the highest mean of 4.62, which is very high, which means that self-regulation strategies of pre-service science teachers in terms of effort regulation are always manifested. This implies that pre-service science teachers constantly monitor their efforts and engagement in lesson planning and delivery to ensure thorough preparation and effective teaching. They seek feedback from their cooperating teachers to refine their teaching strategies and approaches and always maintain a positive mindset. The result aligned with the study of Daria (2023), which intentionally and strategically controls emotions, behavior, efforts, and surroundings to achieve goals effectively. Also, congruent to Waldeyer et al. (2022) and Nishimura & Joshi (2021), students who effectively employ effort regulation strategies demonstrate perseverance in taking demanding academic tasks and maintain a positive outlook on their future and goal attainment.

In comparison, emotional resilience has the lowest mean of 4.43, described as very high, which means that the self-regulation strategies of pre-service science teachers in terms of emotional resilience are always manifested. It implies that PST always focuses on its goals even when faced with difficulties, embraces the challenges of transitioning to a new career, believes in its abilities and qualifications to apply for positions in diverse sectors, including working abroad, views challenges as an opportunity, and manages differences and peer pressures. The result is consistent with the study of Atkins (2021) that the ability to withstand or recover from stress is crucial for preservice science teachers, who face increasing stressors as they become in-service teachers. It significantly impacts teacher retention, well-being, and satisfaction. Further, the findings support the notion of Chowdhury and Smith (2019) that to adapt to

stress and life's challenges, not by being immune to them but by possessing the inner strength and coping mechanisms to recover and progress. Consequently, the result reinforces the idea of Beltman (2021) that interaction between individual teachers' traits and their personal and professional environments results in teachers who demonstrate professional commitment, growth, and well-being.

Table 2. Level of Self – regulation Strategies

Indicators	SD	Mean	Descriptive Level
Goal Setting	0.40	4.61	Very High
Help-seeking	0.41	4.56	Very High
Emotional Resilience	0.40	4.43	Very High
Managing Physical Environment	0.44	4.52	Very High
Effort Regulation	0.35	4.62	Very High
Overall	**0.24**	**4.55**	**Very High**

Level of Instructional Practices

Reflected in Table 3 shows the overall mean of 4.47, which is described as very high, and a variability of 0.30. This means that the instructional practices of pre-service science teachers are always demonstrated, but some individuals may demonstrate these practices more strongly than others. Among the indicators, teaching practices have the highest mean of 4.59, described as very high, which means that the instructional practices of pre-service science teachers in terms of teaching practices are always demonstrated. This implies that PST always promotes collaborative learning experiences, uses hands-on experiments and demonstrations to illustrate scientific concepts, provides opportunities for inquiry-based activities, integrates real-world examples and applications, and effectively uses multimedia resources to enhance student understanding of science. The result of the study is in accordance with the notions of Alber (2015) that to be effective, it includes teacher clarity, classroom discussion, feedback, formative assessments, and metacognitive strategies to promote student learning and achievement through purposeful and intentional instruction. Additionally, it corroborated with the perspectives of Clores and Nueva-España (2023) that effective teaching involves customizing instruction to meet the diverse learning needs of students and employing specific teaching strategies and methods to achieve desired learning outcomes. Substantially, it backs up the insights of Seufert et al. (2021) that prospective teachers benefit from practicing skills through various methods such as videos, role plays, and digital simulations, which enhance authenticity and immediacy in classroom scenario discussions.

Table 3. Level of Instructional Practices

Indicators	SD	Mean	Descriptive Level
Planning Practices	0.48	4.55	Very High
Teaching Practices	0.46	4.59	Very High
Assessment Practices	0.50	4.56	Very High
Project-based Learning Practices	0.57	4.51	Very High
AI and Robotics Integration Practices	0.59	4.16	High
Overall	**0.30**	**4.47**	**Very High**

However, AI and robotics integration practices have the lowest mean of 4.16, described as high, which

means that the instructional practices of pre-service science teachers in terms of AI and robotics integration practices are oftentimes demonstrated. It implies that the PST often integrates AI concepts and robotics into their science teaching, utilizes AI educational tools and robotics to personalize students' learning experiences, and creates assignments and projects that require learners to design, build, and even program robots to solve real-world problems. The result of the study supports the findings of Sun et al. (2024) and Zhang et al. (2023) that acceptance and integration of AI and robotics into pre-service science teacher education can enhance their confidence, self-efficacy, STEM engagement, and positive perceptions toward utilizing these technologies greatly influence its future development and application in education. However, the outcome slightly corresponds to Doğan and Uluay (2021) that most pre-service teachers lacked prior experience with robotics, and even those with some exposure could not recall the programs or mechanisms used, indicating the need for a long-term, individualized learning environment with continuous guidance for adequate robotic implementation studies.

Level of Students' Course Learning Outcomes Attainment

As displayed in Table 4, the result shows an overall mean of 4.52, which is described as very high, with a variability of 0.31. This means that the attainment of course learning outcomes is always evident, and some respondents may achieve outcomes more strongly than others. As found, academic development and educational success have the highest mean value of 4.60, meaning that students' attainment of course learning outcomes in terms of academic development and educational success is always evident. It implies that pre-service science teachers always see the connections between their academic learning in college and real-life experiences, set specific professional development goals, reflect teaching practices regularly to identify areas for personal and professional growth, and are determined to apply for teaching positions driven by their passion in delivering quality science education to diverse learners. The result affirmed Clint's (2021) claim that pre-service teachers must have classroom objectives and skills essential for future professional accomplishments. Notably, it accords with the study of Magulod (2019) that students' academic performance reflects their learning experience, considering intellectual and non-intellectual factors, including learning style preferences, aiming for more effective learning experiences. Consequently, it aligned with the concept of Lucas & Corpuz (2020) that with support and instructional guidance, successful learners can construct meaningful and coherent representations of knowledge.

Table 4. Level of Students' Course Learning Outcomes Attainment

Indicators	SD	Mean	Descriptive Level
Critical Thinking	0.50	4.48	Very High
Communication	0.52	4.51	Very High
Career and Teamwork	0.56	4.44	Very High
Global Understanding and Citizenship	0.48	4.55	Very High
Academic Development and Education Success	0.42	4.60	Very High
Overall	**0.31**	**4.52**	**Very High**

On the other hand, career and teamwork have the lowest mean of 4.44, which is described as very high, which means that students' attainment of course learning outcomes in terms of career and teamwork is always evident. This implies that pre-service science teachers have strong leadership skills, seek

opportunities to collaborate with their peers, demonstrate strong teamwork skills, have a realistic understanding of daily responsibilities, obtain skills to work in a career that will make contributions to society, and actively participate in professional development activities to enhance skills and knowledge in preparation for their teaching career. The result affirmed the study by Floris et al. (2023) that well-defined career goals empower university students to self-regulate their learning and concentrate their effort2s throughout their academic journey. At the same time, it adheres with the study of Prada et al. (2022) that teamwork skills are receiving heightened focus as crucial competencies in an ever-more globalized, dynamic, and complex world.

Significance on Relationships between Pre-Service Science Teachers' Competencies, Self-regulation Strategies, and Instructional Practices on Students' Course Learning Outcomes Attainment

Table 5 presents the relationship between exogenous variables, namely, pre-service science teachers' competencies, self-regulation strategies, and instructional practices, and the endogenous variable, the attainment of course learning outcomes. The results show that all independent variables have a significant relationship with the students' course learning outcomes attainment ($p < .05$). Hence, the null hypothesis is rejected in favor of the alternative hypothesis.

Specifically, there is a significant relationship between pre-service science teachers' competencies and students' course learning outcomes attainment ($r = .548$, $p < .05$). The strength of the correlation between the two variables is a moderately high correlation, as revealed by the r value of .548. Moreover, there is a significant relationship between self-regulation strategies and students' course learning outcomes attainment ($r = .491$, $p < .05$). The strength of the correlation between the two variables is a moderately low correlation, as revealed by the value of .491. Further, there is a significant relationship between instructional practices and students' course learning outcomes attainment ($r = .540$, $p < .05$). The strength of the correlation between the two variables is a moderately high correlation, as revealed by the r value of .540.

Table 5. Significance on Relationships between Pre-Service Science Teachers' Competencies, Self-regulation Strategies, and Instructional Practices on Students' Course Learning Outcomes Attainment

Independent Variables	Course Learning Outcomes Attainment		
	r-value	p-value	Remarks
Pre-service Science Teachers' Competencies	.548***	.000	Significant
Self – regulation Strategies	.491***	.000	Significant
Instructional	.540***	.000	Significant

The results are consistent with the studies of Fauth et al. (2019), who stated that higher teacher competence is positively related to students' interest and achievement of learning outcomes, and Padagas (2018), who revealed that pre-service science teachers who undergo rigorous training will effectively meet the diverse needs of their students leading to the success of their course learning outcomes. Consequently, the results are parallel with the studies of Maharani and Darmawan (2024), who posited that self–regulation strategies such as intrinsic motivation and practical problem-solving skills show a direct relationship to the success of the learning outcomes of the students, and Darmiany et al. (2024) pointed out teachers to fosters student

use of self -regulated learning strategies to influence the learning outcomes of the students. Similarly, the results are aligned with the study of Clores and Nueva España (2023), who elaborated that effective teaching involves customizing instruction to meet the diverse learning needs of students and employing specific teaching strategies and methods to achieve desired students' learning outcomes.

Significance Influence of Pre-service Science Teachers' Competencies, Self – regulation Strategies, and Instructional Practices on Students' Course Learning Outcomes Attainment

The results of linear regression analysis of pre-service science teachers' competencies, self-regulation strategies, and instructional practices on course learning outcomes attainment are presented in Table 6. The extent of influence of the three independent variables on course learning outcomes was shown through the standardized beta values, and their significance was determined through the ρ values.

Notably, the standard coefficient of pre-service science teachers' competencies has a standardized beta value of 0.342. This implies that pre-service science teachers' competencies have the highest degree of influence on course learning outcomes attainment. The regression model is significant, as reflected by a ρ value 0.000. Further, it could be stated that the competencies perceived by the pre-service science teachers significantly positively influence the attainment of course learning outcomes.

The result is similar to the study conducted by Dangdang and Lucero (2023), that the pre-service science teachers were perceived to be very competent, particularly in pedagogical skills, student performance assessment skills, and classroom management skills. Also, in parallel to the findings of Fauth et al. (2019), the higher the teacher competence is positively related to students' interest and achievement, highlighting how teacher effectiveness influences learning outcomes. Accordingly, it is aligned with the notion of Jacobson (2018) that pre-service teachers assigned to classroom environments with highly rated or skilled cooperating teachers are more likely to be effective in the early years of teaching.

Moreover, the standard coefficient beta of instructional practices is 0.319. The regression model is significant, as reflected by ρ value 0.000. It could be concluded that pre-service science teachers' instructional practices significantly influence the attainment of their course learning outcomes. The result is similar to the study of Mufidah (2019) that instructional practices of pre-service science teachers improved their performance by getting feedback from their cooperating teachers. Further, the result argued with the study of Olawale (2024) that student teachers with a comprehensive understanding of the curriculum they will be teaching provide them with practical experiences that enhance their confidence and alleviate their concerns about entering the classroom as certified teachers.

The standard coefficient of self-regulation strategies has the lowest beta value of 0.151. This implies that self-regulation strategies have the lowest degree of influence on students' course learning outcomes attainment. The positive beta value means a positive effect, and it is significant, as reflected by the ρ -value of 0.019. It could be stated that self-regulation strategies of pre-service science teachers have a positive significant influence on their course learning outcomes attainment. The result is similar to the study of Tanak (2020), which states that fostering self-regulatory skills is essential for enhancing educational learning outcomes. Significantly, it accords with the study of Mufidah (2019) that those who employed self-regulation techniques such as goal setting and self–monitoring have a higher levels of self-efficacy, leading to successful learning outcomes.

Table 6. Significance on the Influence of Pre-service Science Teachers' Competencies, Self – regulation Strategies, and Instructional Practices on Students' Course Learning Outcomes Attainment

Students' Course Learning Outcomes Attainment					
(Exogenous Variables)		*B*	β	*t*	*Sig.*
Constant		.326		.977	.329
Pre-service Science Teachers' Competencies		.409	.342	5.777	.000
Self – regulation Strategies		.192	.151	2.363	.019
Instructional Practices		.326	.319	5.260	.000
R	.658				
R^2	.433				
ΔR	.426				
F	57.077				
ρ	.000				

Moreover, looking at the data in Table 6, it is found that all standardized beta coefficient values are positive. Therefore, it could be analyzed that the three exogenous variables, namely, pre-service science teachers' competencies, self-regulation strategies, and instructional practices, positively influence the endogenous variable, which is the course learning outcomes attainment. This elaborated that pre-service science competencies, self-regulation strategies, and instructional practices, as perceived by the respondents, positively contribute to the variations in the level of course learning outcomes attainment were all significant. These are reflected in the regression analysis results where only 43.3 percent of the variance is explained by the three predictor variables as indicated by r^2=0.433, indicating moderate explanatory power. This also implies that while the predictor variables have some influence on the dependent variable, a significant portion of 56.7 percent of the variance remains unexplained by these factors. Among the variables, pre-service science teachers' competencies best predict' students' course learning outcomes attainment.

This finding is consistent with the study of Fauth et al. (2019) that pre-service teachers' competencies, including pedagogical content knowledge, positively influenced students' conceptual understanding and interest in science and significantly enhanced student learning outcomes. Further, the result supported the idea of Conceição et al. (2021) that equipping pre-service science teachers with pedagogical solid content knowledge would enhance their effectiveness in teaching and positively influence their course learning outcomes.

Best - Fit Structural Model of Course Learning Outcomes Attainment

The model fitting was calculated as highly acceptable, as presented in Table 7. As can be gleaned in Figure

1, the best-fit model corporate pre-service science teachers' competencies, self-regulation strategies, and instructional practices are exogenous variables that has direct effect to course learning outcomes attainment. The chi-square divided by the degrees of freedom is 1.270, with a probability of 0.088. This points out a perfect fit of the model to the data. This is also strongly supported by its RMSEA index, which is <0.05 with its corresponding p-close value of >0.05. In the same manner, the other indices, such as NFI, TLI, CFI, and GFI, were found to consistently indicate a very good fit model since all their values reach the criteria.

Further, two of five pre-service science teachers' competencies indicators, namely content knowledge and pedagogical skills, remained significant predictors of students' course learning outcomes attainment. Meanwhile, the self-regulation strategies had three of five indicators: effort regulation, help-seeking, and goal setting. On the other hand, instructional practices had four out of five indicators, namely AI and Robotics integration practices, project-based learning practices, teaching practices, and planning practices. Moreover, there exist covariance between pre-service science teachers competencies and self-regulation strategies, while self-regulation strategies has direct effect to instructional practices. Based on the result, the findings suggest that course learning outcomes attainment of pre-service science teachers among selected institutions of Region XI was best anchored by preservice science teachers' competencies, which were measured in terms of content knowledge and pedagogical skills; self-regulation strategies in terms of effort regulation, help-seeking, and goal setting; and instructional practices in terms of AI and Robotics integration practices, project-based learning practices, teaching practices, and planning practices.

Table 7. Goodness of Fit Measures of Structural Best Fit Model

Indices	Criterion	Model Fit Value
P-value	(>0.05)	.088
CMIN / DF	(0<value<2)	1.270
GFI	(>0.95)	.959
CFI	(>0.95	.966
NFI	(>0.95)	.964
TLI	(>0.95)	.950
RMSEA	(<0.05)	.034
P-close	(>0.05)	.858

Legend: CMIN/DF – *Chi Square/Degrees of Freedom*
NFI –*Normed Fit Index*
GFI – Goodness *of Fit Index*
TLI -*Tucker-Lewis Index*
RMSEA – *Root Mean Square of Error Approximation*
CFI – Comparative *Fit Index*

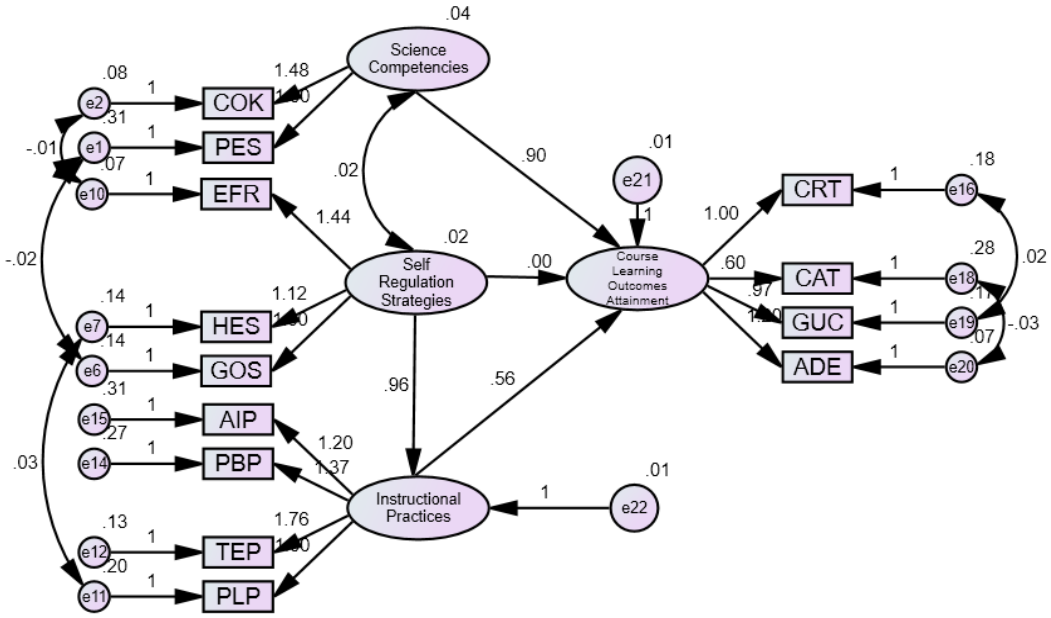

Figure 1: **Generated Structure Best – Fit Model**

Legend

COK – Content Knowledge
PES – Pedagogical Skills
EFR – Effort Regulation
HES – Help-seeking
GOS – Global Understanding and Citizenship
AIP – AI and Robotics Integration Practices
PBP – Project-based learning practices
TEP – Teaching Practices
PLP – Planning Practices
CRT – Critical Thinking
CAT – Career and Teamwork
ADE – Academic Development and Educational Success

4. Conclusion

The findings revealed that pre-service science teachers' competencies, self-regulation strategies, instructional practices, and course learning outcomes attainment are very high as perceived by pre-service science teachers in Region XI. The very high result is evident in the overall mean score of the indicators. When correlated, pre-service teachers' competencies and instructional practices showed a moderately high correlation, and instructional practices showed a moderately low correlation to course learning outcomes attainment. Among the variables, pre-service science teachers' competencies best predict' students' course learning outcomes attainment. The structural analysis of the model, the best fit, yields a good model result. The results confirmed the Environmental – Output (IEO) Model by Astin (1993) that the competencies of pre-service science teachers, which is the input, such as content knowledge and pedagogical skills, are shown to significantly predict students' learning outcomes. These findings reinforce the idea that effective teacher inputs lead to improved educational outputs. Moreover, the findings aligned with the TPACK framework of Mishra and Koehler (2006) by emphasizing that pre-service science teachers who effectively integrate technological tools into their pedagogical practices are better equipped to enhance student outcomes. Further, the study's result that self-regulation strategies, specifically effort regulation, help-seeking, and goal setting, are significant predictors of learning outcomes consistently agreed on the Self-efficacy theory that fostering self-efficacy through targeted training can enhance PST competencies and lead to better learning outcomes.

5. Recommendation

Based on the study's findings and conclusion, researchers recommend Higher Education Institutions (HEIs) to offer specialized courses and workshops focused on strengthening subject matter expertise by integrating targeted review sessions, mock exams, and practice tests into the curriculum to ensure comprehensive preparation for the Licensure Examination for Teachers (LET). Cater regular self-assessment and reflective practices and incorporate new tools and techniques, such as digital organization tools or stress management practices. Offer workshops and training on managing career transitions, such as applying to public schools, shifting careers, or working abroad, providing guidance on adaptability, building a professional network, and offering support systems for navigating these changes. Incorporate training on innovative teaching methods, including integrating AI and robotics in the science curriculum, especially in laboratory settings. Pre-service science teachers could provide hands-on, real-world applications that foster learning outcomes by incorporating AI-driven simulations, robotics projects, and other technology-based tools. Career development workshops and mentorship programs should also be implemented to guide pre-service science teachers in exploring diverse teaching opportunities and advancing their professional growth. Fostering a stronger focus on teamwork and career preparedness will ensure a well-rounded development, enabling them to navigate future careers in local or even global settings. These competencies may leverage the demands of glocal educators. It further recommended that teacher education programs focus on competent teachers who master specific skills and competencies and revisit K-12 teacher training standards, ensuring alignment with Commission on Higher Education, Department of Education, and Professional Regulation Commission for quality education.

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