

**Teaching competencies and self-efficacy as predictors of TLE teachers' preparedness
in integrating green competencies**

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ABSTRACT

The transition toward sustainable, environmentally responsible economies requires education systems to develop learners' green competencies, particularly in technical and vocational education. In the Philippine context, Technology and Livelihood Education (TLE) plays a vital role in equipping students with practical skills aligned with sustainability and green workforce demands. However, the effective integration of green competencies in TLE instruction largely depends on teachers' teaching competencies and self-efficacy. This study examined teaching competencies and self-efficacy as predictors of TLE teachers' preparedness to integrate green competencies in selected public secondary schools in the Department of Education, Danao City, and the Cebu Province Division, Philippines. The study employed a quantitative descriptive–correlational research design using a survey questionnaire administered to 301 TLE teachers. Data were analyzed using frequency and percentage, mean and standard deviation, and regression analysis. The findings revealed that teachers generally demonstrated high levels of teaching competencies, self-efficacy, and preparedness in integrating green competencies. Furthermore, teaching competencies ($\beta = .095$, $t = 2.333$, $p = .020$) and self-efficacy significantly predict teachers' preparedness ($\beta = .741$, $t = 18.217$, $p < .001$), indicating that teachers with greater confidence in their instructional abilities are better prepared to integrate sustainability and environmental concepts into TLE instruction. The results highlight the importance of strengthening teacher capacity through professional development programs that enhance both pedagogical competencies and self-efficacy for sustainability-oriented teaching. Based on the findings, a seminar–workshop program on strengthening TLE teachers' preparedness for integrating green competencies was proposed to support sustainability integration in TLE education.

Keywords: Green competencies, teacher preparedness, self-efficacy, TLE education, sustainability education.

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INTRODUCTION

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The global shift toward greener and more sustainable economies has increased the need for education systems, especially technical and vocational education and training (TVET), to develop green competencies that support sustainable development. International frameworks stress that skills development institutions should prepare learners for environmentally responsible production, consumption, and work practices to promote climate resilience and inclusive growth (Avelar et al., 2019; Tomasella, 2024). These efforts support the United Nations Sustainable Development Goals (SDGs), particularly SDG 4 (Quality Education), SDG 8 (Decent Work and Economic Growth), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action). In this context, teachers, especially those handling applied and skills-based subjects, play an important role in integrating sustainability into education. However, successful implementation of green education depends not only on curriculum design but also on teachers' teaching competencies and their self-efficacy in delivering sustainability-focused instruction (Boeve-de Pauw et al., 2022; Malandrakis et al., 2019).

Teaching competencies refer to teachers' pedagogical, technical, and instructional skills needed to plan, deliver, and assess learning activities that incorporate sustainability principles in practical, performance-based tasks. In sustainability education, these competencies involve explaining environmental concepts, applying systems thinking, and connecting green practices to real workplace situations (Tomasella, 2024). Teacher self-efficacy, on the other hand, refers to teachers' confidence in their ability to manage and carry out teaching tasks successfully. Studies show that teachers with higher self-efficacy are more likely to practice sustainability-oriented teaching, introduce innovations, and continue implementing new curriculum goals (Akça et al., 2019). In vocational and skills-based education, where learning focuses on hands-on performance and workplace relevance, both teaching competence and self-efficacy are key factors in helping teachers effectively integrate green competencies (Yang et al., 2024; Blannin, 2025).

In the Philippine context, national development directions increasingly recognize the urgency of preparing the workforce for the dual transition, green and digital, thereby elevating sustainability as a core concern in education and training systems. National greening initiatives led by Technical Education and Skills Development Authority (TESDA), including the Philippine Green TVET Framework and labor market intelligence on green jobs, explicitly frame sustainability competencies as essential for employability and economic resilience (TESDA, 2018; TESDA, 2023; TESDA, 2024). These initiatives resonate with international guidance from the International Labour Organization (2022), which emphasizes the role of teachers and trainers in ensuring that green skills are meaningfully embedded in training delivery (ILO, 2022). Moreover, "whole-of-institution" approaches advanced in UNESCO-UNEVOC-related literature underscore that sustainable integration requires both competent teachers and supportive institutional environments (UNESCO-UNEVOC/TESDA, 2021).

At the basic education level, particularly in Technology and Livelihood Education (TLE), integrating sustainability presents both opportunities and challenges. Policy frameworks such as the Basic Education Development Plan 2030 and related issuances of the Department of Education (DepEd) emphasize system strengthening and teacher support as prerequisites for achieving priority learning goals, including sustainability-related outcomes (DepEd, 2022; DepEd, 2024). TLE, by design, is competency-based and performance-task-driven, making it a strategic platform for operationalizing green competencies through authentic projects, production activities, and workplace-aligned learning. Yet, the effectiveness of such integration ultimately depends on whether teachers possess sufficient teaching competencies and self-efficacy to embed sustainability concepts meaningfully into daily instruction, beyond compliance with policy mandates.

Despite growing international and national attention to sustainability education, significant research gaps remain. At the global level, much of the existing empirical literature on sustainability integration focuses on higher education or general Education for Sustainable Development (ESD) contexts, with limited predictive studies involving in-service Technology and Livelihood Education (TLE) or Technical-Vocational and Livelihood (TVL) teachers in skills-based and classroom-centered settings (Tomasella, 2024; Duran et al., 2024). Although teacher self-efficacy has been widely explored as an important factor in sustainability teaching, fewer studies have examined it together with teaching competencies as combined predictors of teacher preparedness within a unified explanatory framework (Boeve-de Pauw et al., 2022; Yang et al., 2024). At the local level, while Philippine education policies strongly promote the integration of green skills and sustainability competencies, there is still limited empirical evidence showing how teachers' competencies and self-efficacy influence their actual preparedness to implement these goals in classroom instruction, particularly in applied subjects such as TLE in public secondary schools (TESDA, 2024; ILO, 2022). This gap is more evident in the context of DepEd Danao City and Cebu Province Division, where studies specifically examining TLE teachers' readiness to integrate green competencies remain scarce.

To address these gaps, the present study examines teaching competencies and self-efficacy as predictors of TLE teachers' preparedness to integrate green competencies. Anchored in sustainability and teacher development literature, the study seeks to generate localized Philippine evidence clarifying how what teachers can do and what they believe they can do shape their readiness to embed green competencies in TLE instruction.

Statement of the Problem

This study will examine teaching competencies and self-efficacy as predictors of Technology and Livelihood Education (TLE) teachers' preparedness in integrating green competencies. Specifically, it answered the following questions:

1. What is the profile of the respondents in terms of age, sex, highest educational attainment, years of teaching experience, area of TLE specialization, and number of trainings or seminars attended related to green competencies?
2. What is the level of agreement of the respondents on the following constructs: teaching competencies in terms of curriculum development, job analysis, professional task analysis, construction of curriculum system, and development of project curriculum; curriculum teaching in terms of teaching design, teaching implementation, and teaching evaluation; professional knowledge in terms of professional basic knowledge and knowledge of new technology; occupational ability in terms of occupational communication and cooperation skills, occupational practice skills, and occupational service skills; information literacy in terms of information awareness and attitude, information knowledge and skills, information application and innovation, and information social responsibility; and research and development in terms of research on teaching, professional development, and professional ethics education; self-efficacy; and preparedness in integrating green competencies?
3. Is there a significant relationship of teaching competencies and self-efficacy in TLE teachers' preparedness in integrating green competencies?
4. Is there a moderating effect of self-efficacy in the relationship between teaching competencies and TLE teachers' preparedness in integrating green competencies?
5. Based on the findings, what seminar workshop on strengthening TLE teachers' preparedness for integrating green competencies can be proposed?

METHODOLOGY

This chapter presents the research design, research environment, respondents, research instrument, data gathering procedure, ethical standards, and data analysis employed during the investigation.

This study employed a quantitative, descriptive-correlational research design using a survey to examine the predictive relationships among teaching competencies, self-efficacy, and TLE teachers' preparedness to integrate green competencies. This design is appropriate because it allows the description of teachers' perceptions and the determination of the extent to which the independent variables significantly predict preparedness without manipulating conditions. Data were collected using a structured questionnaire and analyzed using inferential statistical techniques, such as multiple regression and PLS-SEM. The use of a correlational design is supported by Creswell and Creswell (2018), who noted that this approach is suitable for examining relationships and predictive effects among variables in educational research.

The study followed an INPUT-PROCESS-OUTPUT framework to guide the flow of the research. The INPUT included the profile of the respondents in terms of age, sex, highest educational attainment, years of teaching experience, and area of TLE specialization, which provides essential background characteristics of the TLE teachers. It assessed the level of agreement among respondents regarding teaching competencies, self-efficacy, and preparedness to integrate green competencies, using a structured survey questionnaire. In addition, the inputs included data on the moderating effect of self-efficacy on the relationship between teaching competencies and TLE teachers' preparedness to integrate green competencies. Finally, the study considered empirical evidence on the significant influence of teaching competencies and self-efficacy on TLE teachers' preparedness to integrate green competencies, which serves as the basis for the analysis and interpretation of results.

The PROCESS of the study involved crafting appropriate questionnaires to measure respondents' profiles and the study's key constructs. It also involved collecting data from the identified respondent groups using a structured survey. After gathering data, the process involved interpreting it using appropriate statistical tools and computations. This was followed by the analysis and synthesis of results to determine significant differences and relationships among variables. Finally, the process culminated in the preparation of reports presenting the study's findings, conclusions, and recommendations.

The study's OUTPUT is a seminar-workshop on strengthening TLE teachers' preparedness for integrating green competencies, designed based on the study's significant findings. This seminar-workshop will focus on enhancing teachers' teaching competencies and building self-efficacy for sustainability-oriented instruction. It aims to translate research findings into practical professional development activities that enable TLE teachers to effectively integrate green competencies into classroom teaching and learning practices.

This study was conducted in selected public secondary schools under the Department of Education (DepEd) in Danao City and the Cebu Province Division, Cebu, Philippines, with Technology and Livelihood Education (TLE) teachers as the primary respondents. The research examined teachers' teaching competencies and self-efficacy as predictors of their preparedness to integrate green competencies into TLE instruction. Situated in an urbanizing local government unit with growing economic and industrial activities, the DepEd Danao City and Cebu Province Division provides a relevant context for exploring sustainability-oriented and skills-based education aligned with local workforce and community needs. The participating schools offer diverse TLE specializations, exposing teachers to varied instructional demands and opportunities to integrate environmental sustainability and green practices into classroom-based and workshop-based learning. By situating the study within the

DepEd Danao City and Cebu Province Division, the research aims to generate localized and policy-relevant insights that can inform teacher development initiatives, school support mechanisms, and sustainability integration efforts in TLE programs.

The respondents in the study were 301 Technology and Livelihood Education (TLE) teachers from public secondary schools, both in junior and senior high school, in the Department of Education (DepEd) Danao City and Cebu Province Division, Cebu, Philippines. The participants were drawn from various TLE specializations and levels of teaching experience to ensure adequate representation of the TLE teacher population in the division. A simple random sampling technique was employed, wherein each TLE teacher has an equal chance of being selected as a respondent. This sampling method is intended to minimize selection bias and enhance the representativeness and generalizability of the study's findings. The use of simple random sampling in quantitative educational research is supported by Creswell and Creswell (2018), who emphasized that this approach promotes fairness and strengthens the validity of statistical inferences when examining relationships among variables.

The study employed an adapted survey questionnaire as the primary research instrument. The questionnaire is composed of two parts. Part I collects respondents' demographic information, including age, sex, highest educational attainment, years of teaching experience, and TLE specialization. Part II uses survey questions to assess teaching competencies, self-efficacy, and preparedness for integrating green competencies. Responses were measured using a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The teaching competencies were adapted from Diao and Hu (2022) and include six dimensions: curriculum development, curriculum teaching, professional knowledge, occupational ability, informational literacy, and research and development. Self-efficacy items were adapted from Boeve-de Pauw et al. (2022), and preparedness in integrating green competencies was based on the study of Duran and Mariñas (2024).

The measurement model assessment of the constructs indicated that all variables achieved high internal consistency and convergent validity. The Cronbach's alpha values range from 0.933 to 0.961, and the composite reliability values range from 0.943 to 0.965, exceeding the recommended threshold of 0.70, demonstrating strong reliability of the constructs (Hair et al., 2021; Henseler et al., 2016). Moreover, the Average Variance Extracted (AVE) values range from 0.555 to 0.667 and exceed the acceptable minimum of 0.50, confirming adequate convergent validity among the indicators measuring each latent variable (Fornell & Larcker, 1981; Hair et al., 2019). Specifically, Teaching Competencies yielded a Cronbach's alpha of 0.961, a composite reliability of 0.965, and an AVE of 0.555. Self-Efficacy obtained a Cronbach's alpha of 0.933, a composite reliability of 0.943, and an AVE of 0.602. Preparedness in Integrating Green Competencies recorded a Cronbach's alpha of 0.944, a composite reliability of 0.952, and an AVE of 0.667. These findings suggest that the indicators used in the study reliably represent the constructs of teaching competencies, self-efficacy, and preparedness in integrating green competencies, supporting the suitability of the measurement model for further structural model analysis.

Prior to conducting the study, the researcher sought formal approval from the Schools Division Superintendent of the DepEd Danao City Division and from the school heads of the participating public secondary schools to ensure compliance with ethical standards. A formal request letter was submitted outlining the study's purpose, target respondents, research design, and data collection procedures. The researcher developed a structured survey questionnaire aligned with the study's objectives and the constructs of teaching competencies, self-efficacy, and preparedness for integrating green competencies.

After finalizing the research instruments, the researcher administered the survey questionnaire to the selected TLE teachers using a simple random sampling technique. The questionnaires were distributed in print or online, depending on the respondents' availability and accessibility. The researcher clearly explained the study's purpose and provided instructions to ensure respondents fully understood the questionnaire items. During data collection, the researcher monitored responses to address any clarifications and ensure the completeness of the gathered data. Respondent confidentiality was maintained by assigning codes and ensuring that no identifying information is disclosed.

After completing data collection, the researcher reviewed and cleaned the data to ensure completeness, accuracy, and consistency. Incomplete or invalid responses were excluded from the analysis to maintain the reliability of the results. The validated data were coded and entered into appropriate statistical software for analysis. Descriptive and inferential statistical techniques were employed to determine the levels, significant differences, and predictive influences among the study variables. Finally, the researcher prepared a comprehensive report of the findings, conclusions, and recommendations.

The data collected in the study were systematically analyzed using appropriate statistical tools. Frequency count and percentage were used to describe the distribution of respondents across their profile variables, including age, sex, highest educational attainment, years of teaching experience, and TLE specialization, as well as the number of training sessions and seminars attended related to green competencies. Mean and standard deviation were used to determine respondents' levels of agreement regarding teaching competencies, self-efficacy, and preparedness to integrate green competencies, as well as to assess the variability and consistency of their responses. Regression analysis was used to determine the significant influence of teaching competencies and self-efficacy on TLE teachers' preparedness to integrate green competencies and the moderating effect of self-efficacy.

The five-point Likert scale used to measure respondents' level of agreement with the questionnaire statements ranges from 1 to 5, where higher values indicate stronger agreement. A mean score within the range of 4.20 to 5.00 reflects strong agreement, indicating a very high level of agreement and showing that the respondent strongly supports or affirms the statement. Scores within 3.40 to 4.19 indicate agreement, reflecting a generally positive perception of the statement. Mean scores ranging from 2.60 to 3.39 suggest neutrality, indicating neither agreement nor disagreement and reflecting an undecided or moderate perception. Scores between 1.80 and 2.59 indicate disagreement, suggesting that the respondent does not support the statement. Finally, scores between 1.00 and 1.79 indicate strong disagreement, reflecting a very low level of agreement and showing strong opposition or rejection of the statement.

The following terms are operationally defined as they are used in the study. Green Competencies refer to sustainability-related knowledge, skills, values, and practices, such as environmental responsibility, resource efficiency, and eco-friendly practices, that are integrated into TLE instruction as reflected in the survey items. Preparedness in Integrating Green Competencies refers to the degree to which TLE teachers perceive themselves ready to plan, implement, and sustain the integration of green competencies in TLE instruction, as measured by the preparedness scale. Self-Efficacy refers to TLE teachers' perceived confidence in their capability to effectively teach, assess, and manage sustainability-oriented instruction in TLE, as measured by the self-efficacy items in the questionnaire. Teaching Competencies refers to TLE teachers' self-reported teaching competencies in curriculum development, curriculum teaching, professional knowledge, occupational ability, information literacy, and research and development.

RESULTS AND DISCUSION

This chapter presents the results of a quantitative descriptive-correlational study examining the influence of teaching competencies and self-efficacy on the preparedness of Technology and Livelihood Education (TLE) teachers to integrate green competencies in selected public secondary schools under the Department of Education (DepEd) Danao City and Cebu Province Division, Philippines. A total of 301 TLE teachers served as respondents and were selected through a structured survey instrument that assessed their demographic profiles, teaching competencies, self-efficacy in sustainability-related instruction, and preparedness to integrate green competencies into teaching practice. The study was anchored in Social Cognitive Theory and the Theory of Planned Behavior. Descriptive statistics, including frequency, percentage, mean, and standard deviation, were used to characterize the respondents and determine levels of agreement, while regression analysis was employed to examine the predictive and moderating influence of teaching competencies and self-efficacy on preparedness. All results presented in this chapter are interpreted in direct relation to the objectives of the study and are grounded in the data gathered through the survey instrument.

The 301 respondents were distributed across six profile variables: age, sex, highest educational attainment, years of teaching experience, area of specialization, and number of training or seminar sessions attended related to green competencies. In terms of age, the largest group of respondents was aged 36 to 40 years (21.59%), followed closely by those aged 41 to 45 years (20.27%) and 31 to 35 years (19.93%), indicating that most participants were in their mid-career stage. Those aged 26 to 30 years accounted for 12.96%, while respondents aged 46 to 50 years comprised 10.96%, those aged 51 years and above made up 9.63%, and the smallest group consisted of respondents aged 25 years old and below at 4.65%. Regarding sex, the majority were female teachers (80.40%), while male teachers accounted for 19.60%, suggesting that the teaching workforce in the sampled schools is predominantly female. In terms of educational attainment, most respondents were Master's Degree Unit Earners (51.83%), followed by Bachelor's Degree holders (33.55%), Master's Degree Graduates (10.30%), Doctorate Degree Unit Earners (3.32%), and Doctorate Degree Graduates (1.00%), indicating that many teachers are pursuing graduate education as part of their professional development. Regarding teaching experience, the largest proportion of respondents had 11 to 15 years of service (30.56%), followed by those with 6 to 10 years (24.58%), 1 to 5 years (19.93%), 16 to 20 years (16.94%), and more than 20 years (7.97%), suggesting that most participants have substantial teaching experience.

In terms of area of specialization, the majority were from Home Economics (57.48%), followed by ICT (26.91%) and Industrial Arts (12.29%), while those specializing in Agri-Fishery Arts made up a combined 3.32% across two reported sub-entries (2.99% and 0.33%), reflecting the distribution of TLE specialization areas in the participating schools. Regarding exposure to green competency training, most respondents had attended 1 to 3 related trainings or seminars (80.40%), while fewer participated in 4 to 6 trainings (16.61%), and only 2.99% attended seven or more sessions, indicating that although teachers have some exposure to green competency initiatives, opportunities for extensive training remain limited.

Level of agreement on teaching competencies, self-efficacy, and preparedness in integrating green competencies

Teaching competencies

Curriculum development. The respondents' competencies in curriculum development were assessed across four sub-dimensions: job analysis, professional task analysis, construction

of the curriculum system, and development of project curriculum. In terms of job analysis, the results indicate that the respondents demonstrated a high level of competency, with an overall mean of 4.01 and a standard deviation of 0.34, interpreted as Agree. All individual indicators received mean scores ranging from 4.00 to 4.02, suggesting that the teachers can conduct professional investigations, analyze data, and apply industry competence standards in curriculum planning. These findings imply that the respondents possess the necessary skills to align curriculum design with professional standards and industry needs. The ability of teachers to collect and analyze professional competence standards also suggests strong alignment between instructional programs and industry expectations. Effective job analysis in curriculum development is essential because it ensures that educational programs are responsive to labor market demands and professional competencies (Cai et al., 2017). When educators understand job requirements and translate them into curriculum content, learners are better prepared for real-world professional environments. This competence is particularly important in technical and vocational education, where curriculum relevance to industry practices is critical. Therefore, strengthening teachers' job analysis competencies may further enhance curriculum responsiveness and workforce readiness among students (Mohamed et al., 2017).

In terms of professional task analysis, the results indicate that the respondents demonstrated competence with an overall mean of 4.05 and a standard deviation of 0.42, interpreted as Agree. Among the indicators, organizing or participating in task analysis conferences obtained the highest mean of 4.08, indicating that teachers actively collaborate with experts to determine professional competencies, while designing task and professional competency analysis forms obtained a mean of 4.04 and selecting experts according to task analysis requirements obtained a mean of 4.03. These findings highlight that educators recognize the importance of identifying tasks and competencies required in specific professions when designing curriculum content. Task analysis is considered a fundamental step in competency-based education because it identifies the specific knowledge, skills, and abilities necessary for effective job performance (Alainati, 2021). The results also suggest that teachers can select experts and design competency analysis forms to support curriculum development, reflecting a collaborative approach in which industry professionals contribute to defining professional competencies. Such collaboration strengthens the relevance and practicality of academic programs by ensuring alignment with workplace expectations. Studies emphasize that integrating industry expertise in curriculum design improves employability outcomes and enhances the authenticity of learning experiences (Kenaphoom & Niyomves, 2023).

In the sub-dimension of construction of the curriculum system, the respondents demonstrated competence with an overall mean of 4.04 and a standard deviation of 0.41, interpreted as Agree. Teachers reported familiarity with curriculum structures, course content requirements, and the logical relationships between professional competence standards and talent cultivation plans, with individual means ranging from 4.01 to 4.07. These findings indicate that educators can design structured, coherent curriculum systems that integrate theoretical knowledge with practical training (Gunde et al., 2025). The results also show that teachers can design teaching schedules, curriculum plans, and entrepreneurship-oriented training programs, indicating an understanding of the importance of integrating practical experiences and innovation-oriented learning within the curriculum. Modern educational frameworks emphasize that curriculum systems should integrate experiential learning and entrepreneurship education to prepare students for dynamic economic environments. According to Adeoye and Jimoh (2023), comprehensive curriculum frameworks enhance learners' holistic competencies, including creativity, innovation, and problem-solving.

In terms of the development of project curriculum, the respondents obtained an overall mean of 4.05 and a standard deviation of 0.44, interpreted as Agree. Among the indicators, designing project-based courses received the highest mean of 4.10, while interpreting

curriculum plans obtained a mean of 4.07, formulating implementation plans obtained 4.03, and formulating curriculum standards according to professional competence standards obtained 4.00. These results suggest that respondents recognize the importance of project-based learning in enhancing practical skills and problem-solving abilities. Project-based curriculum development allows learners to apply theoretical knowledge in real-world contexts and develop higher-order thinking skills (Loyens et al., 2023). Teachers' ability to formulate curriculum standards and implementation plans aligned with professional competence standards indicates strong alignment between project learning and industry expectations, and research indicates that project-based learning improves student engagement, collaboration, and practical competence in professional education (Juuti et al., 2021).

Curriculum teaching. The respondents' curriculum teaching competencies were assessed across three sub-dimensions: teaching design, teaching implementation, and teaching evaluation. In terms of teaching design, the respondents demonstrated strong competencies with an overall mean of 4.17 and a standard deviation of 0.42, interpreted as Agree. Among the indicators, designing diagnostic evaluations and designing formative evaluations each obtained the highest mean of 4.23, interpreted as Strongly Agree, while preparing training materials and equipment obtained a mean of 4.18, determining teaching strategies and designing a practical teaching environment each obtained 4.17, determining learning tasks and projects obtained 4.14, and clarifying knowledge, skills, and attitude goals obtained 4.08. The findings indicate that the respondents can align learning goals, teaching strategies, and instructional resources to support effective curriculum delivery. Effective instructional design ensures that learning objectives, activities, and assessments are systematically aligned to promote meaningful learning outcomes (Adeyemi, 2026). The respondents' ability to determine learning tasks, prepare training materials, and design practical teaching environments highlights their capacity to create learner-centered instructional experiences, and studies emphasize that well-designed instruction enhances student engagement, promotes deeper understanding, and supports competency development (Chisunum & Nwadiokwu, 2024).

In terms of teaching implementation, the respondents demonstrated competency with an overall mean of 4.17 and a standard deviation of 0.41, interpreted as Agree. The highest mean of 4.22, interpreted as Strongly Agree, was obtained for the use of physical objects, media displays, teaching aids, demonstrations, and experiments, while keen observation, analysis, and coping ability obtained a mean of 4.17, organizing practical training activities and organizing simulated teaching activities each obtained 4.16, and organizing entrepreneurship teaching activities obtained 4.15. These findings indicate that respondents actively employ diverse teaching methods to facilitate students' understanding and engagement. The use of interactive and experiential teaching strategies is recognized as a key factor in improving learning effectiveness and student motivation (Kong, 2021). The respondents' ability to organize practical training, simulated activities, and entrepreneurship instruction demonstrates their competence in delivering applied, skills-based learning experiences, and research highlights that experiential learning activities enhance critical thinking, collaboration, and practical skill development among learners (Hasan et al., 2023).

In the sub-dimension of teaching evaluation, the respondents obtained an overall mean of 4.09 and a standard deviation of 0.39, interpreted as Agree. Individual indicators ranged from 4.04 to 4.12, with organizing and implementing teaching evaluation, analyzing and providing feedback regarding teaching evaluation, and analyzing and providing feedback regarding student learning evaluation each obtaining the highest mean of 4.12. The results indicate that teachers can organize, implement, and analyze various forms of evaluation, including course, teaching, and student learning evaluations, and that respondents recognize

the importance of assessment and feedback in improving instructional practices and learning outcomes. Effective evaluation practices are essential in monitoring student progress and guiding instructional improvement (Okemwa, 2024). Teachers' ability to analyze evaluation results and provide feedback underscores their commitment to reflective teaching practices, and research indicates that timely, constructive feedback significantly improves student achievement and supports continuous instructional development (Younis et al., 2021).

Professional knowledge. The respondents' professional knowledge was assessed across two sub-dimensions: professional basic knowledge and knowledge of new technology. In terms of professional basic knowledge, the respondents demonstrated a strong level with an overall mean of 4.17 and a standard deviation of 0.42, interpreted as Agree. Among the indicators, having relevant work experience obtained the highest mean of 4.20, while having the basic knowledge related to the specialty and having the practical application of basic professional knowledge each obtained a mean of 4.16. These findings suggest that the respondents possess sufficient foundational knowledge and practical expertise necessary to effectively perform their professional responsibilities. Strong professional knowledge enables educators to integrate theoretical concepts with practical applications in their teaching practices (Gess-Newsome et al., 2019). Studies emphasize that teachers with strong subject-matter knowledge and professional experience are better able to deliver high-quality instruction and facilitate meaningful learning experiences (Chan et al., 2018).

In terms of knowledge of new technology, the respondents demonstrated competency with an overall mean of 4.09 and a standard deviation of 0.38, interpreted as Agree. Understanding and striving to learn the application of new technical knowledge obtained the highest mean of 4.11, analyzing the application of new technical knowledge obtained 4.10, and continuously learning advanced technical knowledge in related fields obtained 4.07. These findings suggest that respondents are aware of the importance of staying up to date with technological developments in their fields. In modern education, technological knowledge plays a critical role in enhancing instructional innovation and improving learning experiences (Kalyani, 2024). Teachers' ability to analyze and apply new technical knowledge indicates their readiness to integrate emerging technologies into teaching and learning, and research highlights that teachers who continuously update their technological knowledge are better prepared to adapt to the rapidly evolving educational landscape (Rahimi & Oh, 2024).

Occupational ability. The respondents' occupational ability was assessed across three sub-dimensions: occupational communication and cooperation skills, occupational practice skills, and occupational service skills. In terms of occupational communication and cooperation skills, the respondents demonstrated a high level with an overall mean of 4.10 and a standard deviation of 0.38, interpreted as Agree. Collecting and analyzing industry information and cooperating with industry personnel on projects and training each obtained means of 4.11, while assisting local government in talent-training services obtained 4.08. These findings suggest that educators possess the interpersonal and professional networking skills necessary to engage with external stakeholders and industry partners. Effective communication and collaboration between educators and industry professionals are essential in ensuring that educational programs remain relevant to workforce demands (Mariah et al., 2025). Teachers' ability to assist local government units with talent-training services reflects their active participation in community and workforce development initiatives, and studies emphasize that strong partnerships between schools and external stakeholders contribute to improved training programs and better employment outcomes for learners (Mayomber, 2022).

In terms of occupational practice skills, the respondents demonstrated competency with an overall mean of 4.09 and a standard deviation of 0.38, interpreted as Agree. Among the indicators, guiding students regarding internships obtained the highest mean of 4.12, guiding students to participate in skills competitions obtained 4.11, guiding students to obtain

qualification certificates and participating in the establishment of an off-campus professional training base each obtained 4.09, checking and evaluating the operational status of the campus training base obtained 4.07, and arranging teaching tasks in the campus training base obtained 4.05. The findings indicate that teachers can manage training bases, supervise practical activities, and guide students toward professional certification and skills competitions. Practical training experiences are essential components of competency-based education because they allow students to apply theoretical knowledge in real-world contexts (Poth & Searle, 2021). Research highlights that work-integrated learning opportunities, such as internships and industry placements, significantly improve students' career readiness and professional competence (Jackson, 2018).

In terms of occupational service skills, the respondents demonstrated competence with an overall mean of 4.10 and a standard deviation of 0.41, interpreted as Agree. Among the indicators, producing industrial enterprises' technological achievements obtained the highest mean of 4.14, implementing training and evaluating its effectiveness obtained 4.11, participating in technical activities of industry enterprises obtained 4.10, setting training plans according to industry competency standards obtained 4.09, and analyzing and identifying industry training needs obtained 4.05. These findings suggest that teachers can analyze training needs, design training programs, and evaluate the effectiveness of industry-related training initiatives. Occupational service competencies enable educators to extend their expertise beyond classroom instruction and contribute to industry and community development (Halberstadt et al., 2019). Studies emphasize that teacher involvement in industry-related services enhances the relevance of educational programs and supports the continuous development of professional competencies (Zhao & Ko, 2024).

Information literacy. The respondents' information literacy was assessed across four sub-dimensions: information awareness and attitude, information knowledge and skills, information application and innovation, and information social responsibility. In terms of information awareness and attitude, the respondents demonstrated a high level with an overall mean of 4.22 and a standard deviation of 0.48, interpreted as Strongly Agree. Among the indicators, the awareness of the need to evaluate ICT teaching obtained the highest mean of 4.37, while understanding the important role of information technology in innovating teaching modes, awareness of building and sharing digital teaching resources, and focus on the latest developments in information technology each obtained a mean of 4.19, and consciousness to carry out the integration of information technology and course education obtained 4.18. The findings indicate that teachers are aware of the role of information technology in transforming teaching methods and improving the quality of vocational education. Awareness and positive attitudes toward digital technologies are essential for the successful integration of ICT in teaching and learning processes (Štemberger & Konrad, 2021). Research emphasizes that educators' attitudes and awareness toward ICT significantly influence their willingness to adopt technology-enhanced teaching approaches (Jianjin et al., 2024).

In terms of information knowledge and skills, the respondents demonstrated strong competencies with an overall mean of 4.44 and a standard deviation of 0.53, interpreted as Strongly Agree. Understanding the basic concepts and theoretical basis of ICT teaching and understanding the characteristics and functions of digital teaching resources and teaching tools each obtained a mean of 4.45, while creating digital teaching resources obtained 4.42. The results indicate that teachers understand the basic concepts of ICT teaching, the functions of digital teaching resources, and the process of creating digital learning materials. Knowledge and technical skills in ICT are fundamental components of teachers' digital competence and support effective technology integration in education (Demissie et al., 2022). Studies highlight

that teachers with strong ICT knowledge and skills are better equipped to implement technology-enhanced learning environments and promote digital literacy among students (Sharma, 2023).

In terms of information application and innovation, the respondents demonstrated competence with an overall mean of 4.27 and a standard deviation of 0.46, interpreted as Strongly Agree. The highest mean of 4.37 was obtained for using information technology to create family-school cooperation, followed by applying information technology to communicate with students about learning at 4.35, using information technology to collaborate and communicate with colleagues at 4.28, and using information technology to construct theory-practice and learning-working teaching modes, applying information technology to implement the school-enterprise cooperation teaching model, and using mobile terminals, VR/AR, Internet of Things, 5G, and other technologies each at 4.20. The results suggest that respondents can apply information technology to support collaboration, communication, and innovative teaching models. The effective application of digital technologies enables educators to create flexible and interactive learning environments (Mhlongo et al., 2023). Research indicates that innovative technology applications enhance student engagement, promote collaborative learning, and improve problem-solving skills (Unal & Cakir, 2021).

In terms of information social responsibility, the respondents demonstrated competence with an overall mean of 4.23 and a standard deviation of 0.47, interpreted as Strongly Agree. Ensuring that all students have equal access to learning resources obtained the highest mean of 4.27, cultivating students' knowledge of information security and privacy awareness obtained 4.24, and teaching students the knowledge of laws and regulations related to information technology obtained 4.18, interpreted as Agree. The results show that teachers can ensure equitable access to digital learning resources and promote responsible use of information technology among students. Information social responsibility is an important component of digital literacy because it promotes ethical and safe use of information technologies (Widantari & Adnyana, 2025). Research highlights that digital citizenship education plays a crucial role in developing learners' ethical awareness and responsible participation in digital environments (Al-Abdullatif & Gameil, 2020).

Research and development. The respondents' research and development competencies were assessed across three sub-dimensions: research on teaching, professional development, and professional ethics education. In terms of research on teaching, the respondents demonstrated competency with an overall mean of 4.09 and a standard deviation of 0.39, interpreted as Agree. Among the indicators, carrying out vocational education teaching reform research obtained the highest mean of 4.11, hosting vocational education teaching research projects obtained 4.10, conducting applied science and technology research and transforming scientific research achievements each obtained 4.08. The findings indicate that the respondents possess the capacity to conduct applied research, host research projects, and transform research outcomes into improvements in specialty construction and teaching processes. Conducting research on teaching is essential for improving educational practices because it enables educators to systematically evaluate instructional strategies and identify innovative approaches to learning (Matos et al., 2023). Studies emphasize that teacher-led research strengthens educational innovation and supports the continuous improvement of teaching quality (Lambirth et al., 2021).

In terms of professional development, the respondents demonstrated competence with an overall mean of 4.11 and a standard deviation of 0.39, interpreted as Agree. Among the indicators, proposing goals, tasks, and measures for personal professional development and promoting the development of team building each obtained the highest mean of 4.12, participating in on-the-job training and short-term training obtained 4.11, and mastering professional skills and organizing, designing, and participating in teaching and research

activities each obtained 4.10. The results show that teachers can master professional skills, set professional development goals, and participate in training activities that enhance their competencies. Continuous professional development is essential for educators because it enables them to update their knowledge, refine instructional practices, and adapt to evolving educational demands (Singh, 2026). Research shows that ongoing professional development programs improve teacher effectiveness and enhance student learning outcomes (Samundeeswari et al., 2024).

In terms of professional ethics education, the respondents demonstrated competency with an overall mean of 4.07 and a standard deviation of 0.35, interpreted as Agree. Among the indicators, complying with professional ethics and relevant industry rules and regulations obtained the highest mean of 4.10, evaluating the performance of students' professional ethics obtained 4.09, educating students about professional ethics, laws, and regulations obtained 4.07, and familiarity with and ability to consciously abide by national vocational education laws, regulations, and policies obtained 4.05. The results indicate that teachers are familiar with vocational education laws and regulations, adhere to professional ethical standards, and educate students about ethical practices in their respective fields. Professional ethics education is essential in preparing students to act responsibly and ethically in their future professions (Laidlaw, 2025). Research highlights that ethics education contributes to the development of responsible professionals who can make ethical decisions in complex workplace environments (Kamil et al., 2025).

Self-efficacy

The results indicate that the respondents demonstrated a high level of self-efficacy in integrating green competencies into TLE instruction, with an overall mean score of 4.32 and a standard deviation of 0.48, interpreted as Strongly Agree. The highest-rated indicators included teaching sustainability concepts relevant to TLE subjects (4.43), designing learning activities that promote environmentally responsible practices (4.42), and adapting TLE lessons to include sustainable and eco-friendly practices (4.41). Other indicators obtained the following means: addressing environmental issues within the area of TLE specialization (4.39), managing classroom or workshop activities that promote sustainability (4.37), developing performance tasks that incorporate sustainability principles (4.36), continuously improving teaching to support the integration of green competency (4.25), assessing students' learning outcomes related to green competencies (4.22), using appropriate teaching strategies to integrate green competencies (4.20), and integrating green competencies into TLE lessons (4.19). These findings suggest that TLE teachers possess strong confidence in their ability to implement sustainability-oriented instructional practices, develop relevant learning tasks, and address environmental issues within their specialization.

The results support the idea that teachers' belief in their ability to perform specific instructional tasks significantly influences their willingness to implement innovative, sustainability-based teaching approaches. Research has shown that self-efficacy plays a crucial role in teachers' adoption of new pedagogical practices, particularly in sustainability education and environmental integration in the curriculum (Basilico et al., 2026). The findings also imply that strong teacher self-efficacy can contribute to more effective implementation of sustainability education in TLE, as confident teachers are more likely to design engaging learning experiences and integrate environmentally responsible practices in classroom and workshop activities. The indicators related to developing sustainability-based performance tasks and managing activities that promote sustainability highlight teachers' readiness to

translate sustainability principles into practical learning experiences. According to UNESCO (2021), educators with strong competencies and confidence in sustainability education are better positioned to cultivate environmental awareness, responsible consumption, and sustainable practices among students.

Preparedness in integrating green competencies

The results reveal that TLE teachers generally demonstrated strong agreement that they are prepared to integrate green competencies into their teaching practices, with an overall mean score of 4.25 and a standard deviation of 0.45, interpreted as Strongly Agree. Among the indicators, integrating sustainability and environmental concepts into the TLE curriculum obtained the highest mean of 4.39, followed by making instructional decisions that embed sustainability in TLE lessons (4.34), adapting teaching methods to incorporate green and eco-friendly practices (4.32), planning TLE lessons that include sustainability-related topics and practices (4.32), consistently integrating green competencies into TLE instruction (4.23), applying effective sustainability practices demonstrated by other TLE educators (4.23), participating in professional development activities related to green competencies (4.22), improving ability to integrate green competencies through continuous professional learning (4.20), and using appropriate resources and materials to teach green competencies effectively (4.10) and enhancing students' engagement and learning outcomes through green-competency-based TLE instruction (4.18), both interpreted as Agree.

These findings suggest that TLE teachers demonstrate a positive readiness and commitment to embedding sustainability-related practices in instruction, and the results align with the global emphasis on integrating green competencies in education to support sustainable development and environmental awareness among learners. According to UNESCO (2021), educators play a crucial role in promoting sustainability education by integrating environmental knowledge, responsible practices, and sustainability-oriented learning experiences into the curriculum. The findings also imply that, while teachers demonstrate preparedness, continuous professional learning and institutional support remain important for strengthening the integration of green competencies into teaching. Studies have emphasized that equipping teachers with sustainability-related pedagogical competencies enhances their ability to implement environmentally responsible practices and foster ecological awareness among students (Cebrián et al., 2020).

Significant relationship of teaching competencies and self-efficacy in TLE teachers' preparedness in integrating green competencies

The regression analysis examined the influence of teaching competencies and self-efficacy on TLE teachers' preparedness to integrate green competencies. The findings show that self-efficacy significantly predicted teachers' preparedness ($\beta = .741$, $t = 18.217$, $p < .001$), leading to the rejection of the null hypothesis at the $p < 0.05$ significance level, and indicating that teachers with greater confidence in their instructional abilities are better prepared to integrate sustainability and environmental concepts into TLE instruction. Teaching competencies were also found to have a significant influence ($\beta = .095$, $t = 2.333$, $p = .020$), likewise resulting in the rejection of the null hypothesis at the $p < 0.05$ significance level, suggesting that possessing technical or pedagogical competencies necessarily translates into readiness to implement green competencies. Notably, the substantially larger beta coefficient for self-efficacy relative to teaching competencies implies that teachers' belief in their capability to perform sustainability-related teaching tasks plays a more critical role than their general teaching competencies in predicting preparedness.

These findings are consistent with Bandura's self-efficacy theory, which emphasizes that individuals' beliefs about their capabilities strongly influence their motivation, decision-making, and performance in implementing new practices (Bandura, 1997). Recent studies further support the idea that teachers with high self-efficacy are more likely to adopt innovative, sustainability-oriented teaching practices because they feel more capable of overcoming instructional challenges (Karvonen et al., 2023; Cebrián et al., 2020). The findings have important implications for teacher development and sustainability education in TLE. Since self-efficacy significantly predicts preparedness, professional development programs should focus not only on enhancing teachers' technical competencies but also on strengthening their confidence in implementing sustainability-based instruction. Training initiatives that include hands-on experiences, collaborative learning, and exposure to best practices in green competencies may help increase teachers' instructional confidence and readiness to integrate environmental concepts in their teaching. Research suggests that teachers' confidence in sustainability-related instruction significantly influences the successful integration of education for sustainable development in schools (UNESCO, 2021; Wiek & Redman, 2022).

Moderating effect of self-efficacy in the relationship between teaching competencies and TLE teachers' preparedness in integrating green competencies

The moderation analysis revealed that self-efficacy significantly moderates the relationship between teaching competencies and TLE teachers' preparedness to integrate green competencies, with a β of .459, a t-value of 8.924, and a p-value of $< .001$, leading to the rejection of the null hypothesis at the $p < 0.05$ significance level. This finding suggests that teachers' confidence in their ability to perform sustainability-related instructional tasks strengthens the effect of teaching competencies on their preparedness to integrate green competencies in TLE instruction. In other words, even when teachers possess strong teaching competencies, their level of preparedness becomes more evident when they also have high self-efficacy. This supports the view that teachers' beliefs in their capabilities influence how effectively they apply their knowledge and competencies when implementing innovative or sustainability-oriented teaching practices (López-Alcarria et al., 2019).

Enhancing teachers' self-efficacy can therefore significantly strengthen the application of teaching competencies in sustainability-focused education. When teachers believe in their ability to implement sustainability-oriented teaching strategies, they are more likely to design meaningful learning experiences that foster students' environmental responsibility. This highlights the importance of teacher empowerment and continuous professional support in advancing education for sustainable development in schools (Amzat & Valdez, 2017; Sulaimon & Adebayo, 2024). The findings imply that schools and educational leaders should prioritize professional development programs that build teachers' confidence, practical experience, and capacity in sustainability-oriented teaching, as strengthening TLE teachers' self-efficacy is essential in maximizing the impact of their teaching competencies in integrating green competencies into instruction.

Taken together, the findings of this study establish a coherent and empirically supported account of how TLE teachers in selected public secondary schools in DepEd Danao City and Cebu Province Division perceive and navigate the integration of green competencies into their instructional practice. The 301 respondents demonstrated consistently high levels of agreement across all dimensions of teaching competencies, including curriculum development, curriculum teaching, professional knowledge, occupational ability, information literacy, and research and development, with means ranging from 4.01 to 4.44 across the various sub-dimensions. Their

overall self-efficacy in green competency integration was strong ($M = 4.32$, $SD = 0.48$), as was their reported preparedness ($M = 4.25$, $SD = 0.45$), both interpreted as Strongly Agree. Regression analysis confirmed that both self-efficacy ($\beta = .741$, $t = 18.217$, $p < .001$) and teaching competencies ($\beta = .095$, $t = 2.333$, $p = .020$) significantly predicted preparedness, with self-efficacy emerging as the dominant predictor. Furthermore, moderation analysis revealed that self-efficacy significantly strengthens the relationship between teaching competencies and preparedness ($\beta = .459$, $t = 8.924$, $p < .001$), underscoring that teachers' confidence serves not only as a direct predictor but also as an amplifying condition for the effective application of their competencies. These findings contribute to the growing body of literature on sustainability education and teacher development by demonstrating that, in the context of Philippine TLE instruction, the integration of green competencies is shaped more decisively by teachers' belief in their own instructional capacities than by their competency profiles alone. This has direct implications for how professional development programs are designed and prioritized, and it sets the foundation for the recommendations presented in the subsequent chapter, which proposes a seminar-workshop aimed at enhancing TLE teachers' competencies, self-efficacy, and readiness to advance sustainability-oriented education in the Philippine basic education system.

CONCLUSION

This study concludes that Technology and Livelihood Education (TLE) teachers generally demonstrate strong teaching competencies, high self-efficacy, and a high level of preparedness to integrate green competencies into their instructional practices. However, the findings reveal that self-efficacy plays a more significant role than teaching competencies in predicting teachers' preparedness to integrate sustainability-oriented concepts into TLE instruction. This suggests that teachers' confidence in their capability to implement environmentally responsible practices is a critical factor in translating competencies into actual classroom integration of green competencies. Moreover, the moderating effect of self-efficacy indicates that when teachers have strong confidence in their instructional abilities, they are more effective in promoting sustainability-focused teaching practices. Therefore, strengthening teachers' self-efficacy alongside professional competencies is essential to ensure the successful integration of green competencies in TLE education.

Based on the findings, it is recommended that the Department of Education, school administrators, and teacher training institutions strengthen professional development programs that enhance both teaching competencies and teachers' self-efficacy in sustainability-oriented instruction. Capacity-building initiatives, such as seminars, workshops, and training programs on green education, environmental sustainability, and innovative TLE teaching strategies, should be regularly conducted to equip teachers with up-to-date knowledge and practical skills. Schools should also provide institutional support, resources, and collaborative learning opportunities that encourage teachers to integrate green competencies effectively in classroom and workshop-based learning activities. For future research, scholars may explore additional variables such as institutional support, environmental attitudes, digital green skills, or leadership support that may influence teachers' preparedness in sustainability education, as well as conduct longitudinal or mixed-method studies to gain deeper insights into the long-term impact of green competency integration in technical and vocational education.

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