Sustainable Technology Practices: Its Implementation In Teaching Technology and Livelihood Education

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Abstract

This study determined the implementation of sustainable technology practices in teaching Technology and Livelihood Education (TLE) in selected public secondary schools in the Division of Camarines Norte. Specifically, it examined the extent of sustainable technology practices implemented across the four TLE components—Agriculture, Home Economics, Information and Communication Technology (ICT), and Industrial Arts; determined the developmental support available in terms of professional development and learning resources; identified the challenges encountered by teachers; examined the relationships between sustainable technology practices, developmental support, and challenges; and proposed an intervention program. The study employed a quantitative descriptive-correlational research design involving 79 TLE teachers selected through total enumeration from six mega public secondary schools. Data were collected using an adopted survey questionnaire and analyzed using weighted mean and Spearman's Rank Correlation. Findings revealed that sustainable technology practices were generally sometimes practiced, with ICT obtaining the highest level of implementation, followed by Home Economics, Industrial Arts, and Agriculture. Professional development received a high level of support, while learning resources were moderately available. A significant relationship was found only between sustainable technology practices in Agriculture and developmental support, whereas no significant relationships were found in the remaining TLE components. Likewise, no significant relationship existed between sustainable technology practices and the challenges encountered by teachers. The study recommends strengthening teacher capacity-building programs, improving access to sustainable learning resources, and implementing targeted interventions to enhance sustainable technology integration in TLE instruction.

Keywords: Sustainable technology; technology and livelihood education; instructional activities; agriculture; home economics; information and communication technology; industrial arts; professional development

INTRODUCTION

Education plays an important role in promoting sustainable development by helping learners develop knowledge, skills, and values that support responsible use of resources and environmental protection. The United Nations Sustainable Development Goal 4.7 emphasizes the need for learners to acquire knowledge and skills that promote sustainable development and sustainable lifestyles. UNESCO also highlights the important role of teachers in integrating Education for Sustainable Development into teaching and learning (UNESCO, 2017).

In the Philippine K–12 curriculum, Technology and Livelihood Education (TLE) develops practical skills, technological knowledge, work values, entrepreneurship, and competencies that can prepare learners for employment and further education (Department of Education [DepEd], 2016). Integrating sustainable technology practices into TLE can therefore connect technical skills with environmental responsibility. It can also provide learners with opportunities to apply practical and innovative solutions while promoting the responsible use of materials, energy, and other resources.

The integration of sustainability in TLE, however, depends not only on curriculum content but also on teachers' competencies, available resources, institutional support, and professional development. UNESCO (2017) emphasizes the need to strengthen teachers' capacity to integrate sustainability into education, particularly in secondary and technical-vocational education. Thus, teachers need adequate knowledge, skills, resources, and support to effectively implement sustainable practices in their classrooms.

In the Philippine setting, sustainability-related practices such as resource conservation, recycling, livelihood activities, and community-based projects provide opportunities for integrating environmental responsibility into practical education. However, there is limited empirical evidence on the actual implementation of sustainable technology practices among TLE teachers, particularly in public secondary schools in Camarines Norte. Existing discussions commonly focus on

teacher competencies, instructional innovation, or technology integration rather than examining sustainable technology practices across different TLE specialization areas. This gap provides the basis for the present study.

The findings of this study may provide useful evidence for improving sustainable technology practices in TLE instruction. The results may guide teachers, school administrators, curriculum planners, and other education stakeholders in developing appropriate professional development activities, providing learning resources, and strengthening sustainability-oriented teaching practices.

METHODOLOGY

This study used a quantitative research approach with a descriptive-correlational research design to determine the implementation of sustainable technology practices in Technology and Livelihood Education (TLE). The descriptive method was used to determine the level of implementation of sustainable technology practices in the four TLE components: Agriculture, Home Economics, Information and Communication Technology (ICT), and Industrial Arts. It also assessed the developmental support available to teachers and the challenges they encountered. The correlational method was used to determine the significant relationships between sustainable technology practices and developmental support, as well as between sustainable technology practices and the challenges encountered by teachers. This design was appropriate because it described existing conditions and examined relationships among variables without manipulating them.

The study was conducted in six public secondary Mega Schools in the Division of Camarines Norte during School Year 2025–2026. The schools were selected because they offered the four major TLE components and were among the largest public secondary schools in the province. For confidentiality, they were identified as Mega School A, B, C, D, E, and F.

The respondents were 79 TLE teachers selected through total enumeration. All qualified TLE teachers from the selected schools were included because the population was manageable. They represented the four TLE components and were directly involved in classroom instruction, making them appropriate sources of information about sustainable technology practices. A survey questionnaire was the main research instrument which was adopted from Conda and Benavides (2024), Smerdon, et.al (2000) and Oraye and Dy (2021).

RESULTS AND DISCUSSIONS

Sustainable Technology Practices Currently Implemented by TLE Teachers in Instructional Activities

a. *Agriculture*. It shows that sustainable technology practices in Agriculture were sometimes practiced with an overall weighted mean of 2.76**.** The highest indicators were evaluating students' knowledge of agricultural technology and integrating ICT in sustainable agriculture lessons, while the lowest were the use of virtual laboratories and digital farm planning tools. This means that teachers are beginning to integrate technology in Agriculture instruction, but the use of advanced digital tools is still limited due to lack of resources, training, and facilities. Classroom observations further support these findings. Agriculture lessons are commonly conducted through discussions, demonstrations, and school-garden activities. Students also create farm layouts manually because digital planning tools, appropriate devices, and specialized software are limited. These findings are consistent with Johnson (2022), who emphasized that teachers' environmental attitudes influence their use of sustainable practices, and Singh (2021), who highlighted the importance of adequate resources and school support in adopting sustainable technologies. Overall, sustainable technology practices in Agriculture are present but not yet consistently implemented. Improved access to digital resources, teacher training, and technological support may help strengthen their integration into Agriculture instruction.

Table 1. Sustainable Technology Practices Currently Implemented by TLE Teachers in Instructional Activities along Agriculture

Indicators	Weighted Mean	Interpretation
1. Utilize agricultural software and applications to demonstrate concepts.	2.76	SP
2. Evaluate students' ability to access and use online agricultural databases and resources.	2.72	SP
3. Assess whether teachers incorporate agricultural simulations and virtual labs.	2.62	SP
4. Evaluate students' knowledge of agricultural technology equipment and their ability to	2.95	SP

	demonstrate their use.		
5.	Guide students in creating digital farm plans using digital tools.	2.62	SP
6.	Encourage students to collaborate online for agricultural research projects, leveraging platforms for data collection, analysis, and reporting.	2.71	SP
7.	Evaluate teachers' capacity to integrate ICT into lessons on sustainable agriculture practices, emphasizing concepts.	2.95	SP
	Overall Weighted Mean	2.76	SP

b. Home Economics. It reveals that sustainable technology practices in Home Economics were sometimes practiced with an overall weighted mean of 3.18**.** Teachers commonly used technology to improve student engagement and lesson delivery, while digital literacy instruction received the lowest mean. The findings imply that technology is moderately integrated in Home Economics classes, but its use is not yet consistent and still needs improvement through training and better access to digital resources. The findings are supported by Stevens and Carter (2022), who emphasized the value of energy-efficient equipment in Home Economics. Using energy-saving appliances can reduce electricity consumption while helping students understand practical ways of promoting sustainable living. Overall, sustainable technology practices in Home Economics are present but not yet consistently implemented. Increased access to digital resources, teacher training, and energy-efficient equipment may strengthen technology integration and promote more meaningful and sustainable learning experiences.

Table 2. Sustainable Technology Practices Currently Implemented by TLE Teachers in Instructional Activities, along with Home Economics

Indicators	Weighted Mean	Interpretation
1. Incorporates a variety of digital resources to enhance the Home Economics lesson.	3.24	SP
2. Design assessments that leverage technology to evaluate students' understanding and progress.	3.15	SP
3. Utilize collaborative tools to facilitate group projects and real-time collaboration among students in a lesson.	3.14	SP
4. Teach digital literacy skills, ensuring that students can navigate and use digital tools and equipment effectively and responsibly.	3.09	SP
5. Educate students about online safety, ethical behavior, and responsible use of technology.	3.11	SP
6. Evaluate students' capacity to troubleshoot independently, which minimizes disruptions to the learning process.	3.13	SP
7. Assess the level of student engagement in technology-integrated lessons.	3.37	SP
Overall Weighted Mean	3.18	SP

c. Information and Communication Technology. It indicates that sustainable technology practices in ICT were often practiced with an overall weighted mean of 3.78. The highest practice involved teaching students about ICT hardware and troubleshooting, while project management tools and digital portfolios obtained the lowest means. This suggests that ICT teachers are actively integrating technology in instruction, especially in practical and hands-on activities, although some advanced practices still require further enhancement. The findings are supported by Kumar et al. (2020), who found that digital tools improve students' digital skills and encourage independent learning while reducing paper use. Similarly, Zhang (2023) reported that solar-powered mobile ICT laboratories can reduce operating costs and provide access to technology in resource-limited areas while promoting the use of renewable energy. Overall, sustainable technology practices in ICT are often practiced, showing stronger technology integration compared with the other TLE components. Continued teacher training and access to digital and renewable-energy technologies may further strengthen ICT instruction.

Table 3. Sustainable Technology Practices Currently Implemented by TLE Teachers in Instructional Activities, along with ICT

Indicators	Weighted Mean	Interpretation
1. Utilize a variety of software and applications relevant to ICT.	3.78	OP
2. Teach students essential digital literacy skills, including online safety, responsible use of technology, and effective internet searching.	3.81	OP
3. Incorporate project-based learning approaches to solve real-world problems, fostering creativity and critical thinking.	3.82	OP
4. Guide students in creating multimedia content to enhance their communication and presentation skills.	3.78	OP
5. Teach students about ICT hardware components, troubleshooting common issues, and understanding the principles of computer hardware.	3.89	OP
6. Introduce project management methodologies and tools to help students plan and execute ICT projects effectively.	3.67	OP
7. Assess students' ICT skills and progress through digital portfolios.	3.67	OP
Overall Weighted Mean	3.78	OP

d. Industrial Arts. It shows that sustainable technology practices in Industrial Arts were sometimes practiced with an overall weighted mean of 2.93. Teachers commonly used online resources to support instruction, while the use of 3D printing and prototyping technologies received the lowest rating. The findings indicate that modern technologies are only partially integrated and still developing in Industrial Arts due to limited tools, facilities, and technical support. Improving access to modern equipment, providing continuous teacher training, and strengthening technical support may increase the use of digital and sustainable technologies and better prepare learners for technology-driven industries.The findings are supported by Ortiz (2023), who emphasized that teacher training and professional support increase teachers' confidence and ability to apply sustainable practices. Similarly, Zhang (2023) highlighted the potential of solar-powered technologies in reducing energy costs and providing access to technology in resource-limited settings. In Industrial Arts, solar-powered or energy-efficient tools can support practical activities while teaching students the importance of clean energy and environmental responsibility. Overall, sustainable technology practices in Industrial Arts are present but not yet consistently implemented, highlighting the need for improved resources, training, and technological support.

Table 4. Sustainable Technology Practices Currently Implemented by TLE Teachers in Instructional Activities along Industrial Arts

Indicators	Weighted Mean	Interpretation
1. Create and utilize digital blueprints and design software for Industrial Arts projects.	2.85	SP
2. Evaluate students' ability to incorporate 3D printing and prototyping technology into Industrial Arts projects.	2.82	SP
3. Assess whether teachers use simulation software to teach electronics concepts and circuit design in a virtual environment.	2.99	SP
4. Introduce programming concepts for automation and robotics projects.	2.91	SP
5. Evaluate students' ability to integrate Internet of Things (IoT) devices and sensors into the Industrial Arts project.	2.92	SP
6. Involving the incorporation of digital resources and simulations to teach students about Industrial Equipment safety and maintenance procedures.	2.92	SP
7. Assess whether teachers effectively curate and utilize online resources to supplement classroom instruction.	3.08	SP
Overall Weighted Mean	2.93	SP

Developmental Support Available in Implementing Sustainable Technology Practices

a. Professional Development. It presents that developmental support along professional development was generally rated Agree with an overall weighted mean of 3.87. Teachers strongly agreed that schools require technology training, while support for integrating telecommunications into the curriculum received the lowest rating. This implies that schools provide training opportunities for teachers, but more practical support is still needed to help teachers apply technology effectively in instruction. This indicates that although some support exists, teachers may need more guidance on applying telecommunications and other technologies in actual classroom instruction. This also suggests a gap between attending training and effectively applying what was learned. The findings are supported by Lee and Chang (2023), who found that professional development workshops can improve teachers' confidence and skills in using sustainable technologies. In practice, teachers who receive training on digital tools and energy-saving practices may become more confident in using projectors, online assessments, and digital submissions instead of printed materials. Overall, teachers perceive strong professional development support, but continuous mentoring, hands-on training, and follow-up assistance are needed to help teachers apply sustainable technology practices more effectively in their daily instruction.

Table 5. Developmental Support Available in Implementing Sustainable Technology Practices along Professional Development

Indicators	Weighted Mean	Interpretation
My school or district……		
1. Require technology training for teachers	4.39	SA
2. Encourage technology training with incentives	3.96	A
3. Leave it up to teachers to initiate participation in training	3.73	A
4. Has lack of support regarding ways to integrate telecommunications into the curriculum	3.06	SIA
5. Provide adequate training opportunities	3.94	A
6. Provides release time from classes or other responsibiliti	4.00	A
7. Provide course credit toward certification	4.00	A
Overall Weighted Mean	3.87	A

*b. Learning Resources***.** It reveals that support in terms of learning resources was rated Slightly Agree with an overall weighted mean of 3.35. Schools strongly considered students' access to learning materials, while lack of technical support received the lowest mean. This indicates that although schools recognize the importance of learning resources, challenges such as limited internet access, outdated computers, and insufficient technical support still affect technology integration. The findings suggest that improving internet connectivity, providing updated equipment and sufficient devices, and offering regular technical assistance can strengthen the use of sustainable learning resources. Continuous training and clear guidance may also increase teachers' confidence in using technology and reduce dependence on printed materials. The findings are supported by Pan and Filippova (2024), who emphasized the importance of access to educational technology and appropriate learning resources in supporting effective technology integration. Johnson (2020) also highlighted that teachers' attitudes, beliefs, and readiness influence how effectively available sustainable technologies are used. Overall, schools provide basic learning materials, but stronger technical support and improved access to digital resources are needed to promote more effective and sustainable technology integration.

Table 6. Developmental Support Available in Implementing Sustainable Technology Practices along Learning Resources

Indicators	Weighted Mean	Interpretation
My school or district……		
1. Is concern about student access to appropriate materials	4.30	SA
2. Has lack of time in the schedule for students to use computers in class	3.48	A
3. Lack of technical support or advice	2.91	SIA
4. Internet access is not easily accessible	3.32	SIA
5. Has good instructional software	3.47	A
6. Has outdated, incompatible, or unreliable computers	3.06	SIA
7. Has enough computers for students and teachers	2.94	SIA
Overall Weighted Mean	3.35	SIA

Relationship between the Sustainable Technology Practices and the Developmental Support Available in its Implementation.

It shows the relationship between sustainable technology practices and developmental support. Agriculture had a significant positive relationship with both professional development and learning resources, while Home Economics, ICT, and Industrial Arts showed no significant relationship. This means that developmental support plays a more important role in strengthening technology practices in Agriculture compared to the other TLE areas. The findings suggest that Agriculture is more closely associated with developmental support, particularly access to learning resources. This may be because Agriculture instruction often requires specialized tools, equipment, and technology-based resources. For the other TLE components, factors such as teachers' confidence, beliefs, familiarity with technology, and subject-specific practices may also affect technology integration. These findings highlight the need for subject-specific training, adequate resources, mentoring, and classroom-based technical support rather than relying only on general professional development programs. The findings are supported by Turner (2023), who found that both online and face-to-face professional development improved teachers' skills in using sustainable technologies, with face-to-face training providing stronger participation and understanding. Furthermore, the results show that developmental support is important but does not affect all TLE components in the same way. Strengthening targeted training and providing appropriate learning resources may be particularly important in improving sustainable technology practices in Agriculture.

Table 7. Test for a Significant Relationship between the Sustainable Technology Practices and the Developmental Support Available in the Implementation

	Developmental Support			
	Professional Development		Learning Resources	
Sustainable Technology Practices	*ρ*	*p-value*	*ρ*	*p-value*
Agriculture	.275*	.014	.314**	.005

Home Economics	.123	.279	.044	.698
ICT	.143	.210	.215	.057
Industrial Arts	.185	.102	.112	.328

**Correlation is significant @ 0.05 level (2-tailed)*
***Correlation is significant @ 0.01 level (2-tailed)*

Challenges Encountered by TLE teachers in Implementing the Sustainable Technology Practices in their Instruction, Along with TLE Components

a. Agriculture. It shows that teachers encountered challenges in implementing sustainable technology practices in Agriculture, with an overall weighted mean of 3.57**.** The broad course content was the most common challenge, while making rubrics was the least encountered. This indicates that teachers struggle more with limited time, resources, and instructional materials than with assessment-related tasks. The findings are consistent with Ng (2020), who reported that greater challenges faced by teachers were associated with lower implementation of sustainable practices. Limited training, resources, and administrative support can reduce teachers' ability to consistently apply sustainable technologies. Overall, addressing curriculum pacing, instructional resources, and institutional support may help teachers overcome these challenges and strengthen sustainable technology practices in Agriculture.

Table 8. Challenges Encountered by TLE Teachers in Implementing the Sustainable Technology Practices in Instruction along with Agriculture

Indicators	Weighted Mean	Interpretation
1. Independent knowledge and skills in preparing and utilizing instructional materials	3.57	E
2. Unavailability of resources	3.59	E
3. Lack of learning modules and other resources	3.54	E
4. Coverage of course content is broad	3.80	E
5. Time allotment is too short	3.68	E
6. Inadequate relevant instructional aids to help make the teaching – learning effective	3.76	E
7. Difficulty in making rubrics for classroom activities	3.05	ME
Overall Weighted Mean	3.57	E

b. Home Economics. It reveals that teachers encountered challenges in Home Economics with an overall weighted mean of 3.59. The lack of tools was the greatest challenge, while lack of professional development was moderately encountered. The findings imply that insufficient facilities, tools, and learning materials affect the effective implementation of sustainable technology practices in Home Economics. When resources are unavailable, teachers often rely on printed materials, visual aids, demonstrations, or improvised and recycled materials. This can reduce students' opportunities for hands-on learning and meaningful technology integration. The findings are supported by Barcelona et al. (2023), who identified inadequate resources and institutional support as barriers to implementing technology- and sustainability-oriented programs. Similarly, Genizera et al. (2022) found that consistent implementation of DepEd sustainability initiatives can improve environmental awareness and create a more supportive learning environment. Overall, improving tools, facilities, instructional materials, and institutional support is necessary to strengthen sustainable technology practices and provide more practical learning experiences in Home Economics.

Table 9. Challenges Encountered by TLE Teachers in Implementing the Sustainable Technology Practices in Instruction along with Home Economics

Indicators	Weighted Mean	Interpretation
1. Lack of tools	3.73	E
2. Insufficient LM's	3.59	E
3. Limited access to teachers training	3.66	E
4. Lack of professional development	3.35	ME
5. Inadequate laboratory facilities	3.67	E
6. Students' low interest	3.54	E
7. Students' difficulty	3.58	E
Overall Weighted Mean	3.59	E

c. Information and Communication Technology. It indicates that challenges in ICT were **moderately encountered** with an overall weighted mean of **3.32**. The insufficient number of computers was the most serious challenge, while integrating ICT into the curriculum was the least encountered. This suggests that ICT teachers experience moderate difficulties mainly related to infrastructure and availability of equipment. The findings indicate that inadequate ICT equipment and technical resources remain the main challenges. Although ICT teachers generally possess basic technology skills, limited hardware, technical support, and appropriate instructional approaches may prevent the full integration of sustainable technology practices. The findings are supported by Reyes (2020), who noted that the high initial cost of renewable-powered ICT technologies can slow their adoption in schools. This highlights the need for adequate funding, partnerships, and institutional support to improve access to sustainable technologies, particularly in public schools. Overall, improving ICT infrastructure, technical support, and funding can help teachers move beyond basic technology use toward more effective and sustainable ICT-based instruction.

Table 10. Challenges Encountered by TLE Teachers in Implementing the Sustainable Technology Practices in Instruction along with ICT

Indicators	Weighted Mean	Interpretation
1. Insufficient number of computers	3.72	E
2. School computers are out of date and/or need repair	3.59	E
3. Insufficient technical support for teachers	3.34	ME
4. Insufficient pedagogical support for teachers	3.22	ME
5. Lack of pedagogical models on how to use ICT for learning	3.14	ME
6. Lack of adequate content/material for teaching	3.29	ME
7. Too difficult to integrate ICT use into the curriculum	2.94	ME
Overall Weighted Mean	3.32	ME

d. Industrial Arts. It shows that teachers encountered challenges in Industrial Arts with an overall weighted mean of 3.48. The lack of tools and facilities were the most common problems, while students' inability to follow directions was only moderately encountered. This means that resource-related issues remain the major barrier in implementing sustainable technology practices in Industrial Arts. The findings show that resource availability and institutional support should be prioritized. Schools may maximize available resources through recycling, improvising materials, sharing equipment, and seeking support from local government units, parents, and community partners. The findings are supported by Kim and Lee (2022), who identified inadequate funding and equipment maintenance as major barriers to implementing sustainable technologies in schools. Similarly, Ng (2020) found that greater challenges are associated with lower implementation of sustainable practices, emphasizing the need for adequate resources, training, and administrative support. Overall, providing sufficient tools, proper maintenance, training, and continuous institutional support can help teachers strengthen sustainable technology practices in Industrial Arts and provide learners with more meaningful hands-on experiences.

Table 11. Challenges Encountered by TLE Teachers in Implementing the Sustainable Technology Practices in Instruction along Industrial Arts

Indicators	Weighted Mean	Interpretation
1. Lack of tools to be used	3.66	E
2. No adequate facilities/laboratories	3.58	E
3. Have insufficient learning materials	3.59	E
4. Lack of a suitable fund to purchase the required tools and materials	3.58	E

5.	Lack of support for other concerned authorities	3.37	ME
6.	Problem with the learner's cooperation	3.32	ME
7.	Learners are incapable of fully adhering to the teacher's direction	3.28	ME
	Overall Weighted Mean	3.48	E

Relationship Between Sustainable Technological Practices and Challenges Encountered by Teachers.

It presents that there was no significant relationship between sustainable technological practices and the challenges encountered by teachers across all TLE areas. Although weak positive and negative correlations were observed, all p-values were greater than 0.05. This implies that the challenges experienced by teachers may be influenced by other factors such as resources, administrative support, and training rather than the level of sustainable technology practices alone. These findings indicate that the level of sustainable technology practices is not significantly associated with the challenges experienced by teachers. The weak correlations suggest that other factors may better explain the challenges, such as availability of resources, teacher training, administrative support, infrastructure, workload, and institutional policies. The findings are consistent with Fischer et al. (2022), who emphasized that teachers may face barriers such as limited training, inadequate resources, heavy workloads, and insufficient school support when implementing sustainable technology practices. This highlights that successful sustainability integration depends not only on teachers' classroom practices but also on the support provided by schools and other stakeholders. Overall, the results suggest that addressing teachers' challenges requires broader institutional support, including adequate resources, relevant training, technical assistance, and supportive school policies.

Table 12. Test for a Significant Relationship between Sustainable Technological Practices and Challenges Encountered by Teachers

Sustainable Technological Practices	Challenges Encountered by Teachers		Remarks
	ρ	*p-value*	
Agriculture	.036	.754	Not Significant
Home Economics	-.201	.076	Not Significant
Information and Communication Technology	-.215	.057	Not Significant
Industrial Arts	.051	.656	Not Significant

Correlation is not significant if p>.05 level

Proposed Intervention to Strengthen Sustainable Technology Practices in the Teaching and Learning the TLE Subject.

The findings of the study revealed the need to strengthen sustainable technology practices in TLE instruction. Thus, the proposed intervention, "Sustainable Technology Practices in TLE Instruction: Advancing Education Through Innovation and Sustainability," was developed to address challenges related to limited resources, insufficient training, and technology integration across the different TLE components. The intervention is aligned with Sustainable Development Goal 4 (SDG 4), which promotes quality and inclusive education through the development of relevant skills and competencies. It also supports DepEd Order No. 24, s. 2020 (PPSSH) and DepEd Order No. 42, s. 2017 (PPST) by promoting teacher development, instructional improvement, and effective technology integration. The intervention focuses on providing teacher training, technical support, and accessible learning resources to enhance the implementation of sustainable technology practices in TLE. A key output is the development of a digital and printed coffee-table reference material containing practical strategies and best practices in Agriculture, Home Economics, ICT, and Industrial Arts. Through this intervention, teachers will be better equipped to integrate sustainable technology into instruction, improve student learning experiences, and promote quality and sustainable education.

Conclusions

This study determined the implementation of sustainable technology practices in teaching Technology and Livelihood Education (TLE) among public secondary school teachers in the Division of Camarines Norte. Based on the findings, the following conclusions were drawn:

1. Sustainable technology practices are implemented at varying levels across the four TLE components. Information and Communication Technology (ICT) demonstrated the highest level of implementation, while Agriculture showed

the lowest, indicating that technology integration remains uneven across specialization areas. Greater attention is needed to strengthen sustainable technology implementation, particularly in Agriculture and Industrial Arts.

2. Teachers receive adequate professional development opportunities that enhance their knowledge and competence in sustainable technology integration. However, the availability and accessibility of learning resources require further improvement to ensure consistent implementation of sustainable instructional practices across all TLE components.
3. Developmental support significantly influences sustainable technology practices in Agriculture but not in Home Economics, ICT, and Industrial Arts. This finding suggests that Agriculture teachers rely more heavily on institutional support due to the specialized nature of agricultural technologies and instructional resources.
4. Teachers continue to encounter challenges in implementing sustainable technology practices, particularly in Home Economics. These challenges indicate the need for continuous updating of teachers' technological competencies and improved access to instructional technologies and facilities.
5. The absence of a significant relationship between sustainable technology practices and the challenges encountered suggests that teachers remain committed to implementing sustainable instruction despite existing constraints. The challenges experienced appear to be influenced more by institutional and contextual factors than by teachers' instructional practices alone.
6. The proposed intervention program, "Sustainable Technology Practices in TLE Instruction: Advancing Education Through Innovation and Sustainability," is appropriate for addressing the identified gaps by strengthening teacher competence, improving access to sustainable learning resources, and promoting the consistent integration of sustainable technology across all TLE components.

Recommendations

Based on the findings and conclusions of the study, the following recommendations are offered:

1. School administrators should strengthen sustainable technology implementation by providing specialized training, mentoring, and technical assistance, particularly for teachers handling Agriculture and Industrial Arts.
2. The Department of Education and school administrators should prioritize the procurement and equitable distribution of sustainable instructional technologies, digital learning resources, renewable energy equipment, and specialized instructional materials to improve classroom implementation.
3. Professional development programs should continuously address emerging sustainable technologies, environmental education, digital innovation, and instructional strategies to enhance teachers' technological competence across all TLE specialization areas.
4. Stronger partnerships among schools, local government units, higher education institutions, industries, and other stakeholders should be established to support sustainability initiatives through resource sharing, technical assistance, and collaborative projects.
5. Future researchers may replicate this study using larger populations, different educational settings, or mixed-methods approaches to gain a more comprehensive understanding of sustainable technology implementation in Technology and Livelihood Education.

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