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From Bean to Cup: Assessing the Effectiveness of a Coffee Processing Module

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Abstract. Specialty coffee processing is an area of growing educational significance. This study developed and evaluated a specialty coffee processing module for high school students enrolled in the Technical-Vocational-Livelihood (TVL) strand in Palimbang District, Sultan Kudarat. Using a quantitative, descriptive-evaluative approach, the research assessed the module's effectiveness based on student learning, engagement, and satisfaction. Results showed a significant increase in student knowledge, with post-test scores (40.22 ± 5.06) surpassing pre-test scores (16.19 ± 5.13), resulting in a mean difference of 24.03 and a retention rate of 71.08%. Expert evaluations rated the module high quality across all factors, with an average score of 3.83 out of 4.0, particularly excelling in accuracy and reliability (4.00 ± 0.00). Student satisfaction levels were also notably high, with an overall mean score of 4.60 ± 0.38, suggesting a very high extent of quality relevance. These results indicate that integrating specialty coffee processing education into vocational training can enhance student learning outcomes and engagement, supporting its inclusion in future curricula.

Keywords: Specialty coffee; Learning module; Educational effectiveness; Technical-Vocational- Livelihood (TVL) strand; Agricultural education.

1.0 Introduction

The Philippine coffee industry holds significant potential in the global market. There are only four commercially viable varieties of coffee: Arabica, Liberica, Robusta, and Excelsa. Only a few countries, including the Philippines, have the right climatic and soil conditions to grow the four varieties of coffee (Philippine Coffee Board, 2025). Coffee, after petroleum, is the world's second most traded commodity, and in the Philippines, it is an essential agricultural product, providing income for farmers and creating employment opportunities in coffee-growing areas (Chengappa & Devika, 2016; Luat et al., 2021, 2022; Sumaya et al., 2023). The municipality of Senator Ninoy Aquino in the province of Sultan Kudarat, dubbed as the coffee capital of the Philippines, has emerged as a major producer of specialty coffee and garnered recognition locally and internationally. Specialty coffee, characterized by its superior taste and high-quality standards, necessitates meticulous processing techniques that significantly impact the final product's flavor and marketability (Sepúlveda et al., 2016). Teaching specialty coffee production methods not only enhances product quality but also allows local producers to compete in international markets (Ramírez-Correa et al., 2020; Urwin et al., 2019). As global demand for specialty coffee continues to rise, equipping students with industry-specific knowledge and technical skills presents an opportunity to sustain and advance the local coffee sector.

Despite the economic significance of coffee production, formal education on specialty coffee processing remains limited, particularly at the high school level. The Philippine Department of Education (DepEd) emphasizes the need for practical, industry-relevant training within the Technical-Vocational-Livelihood (TVL) strand to bridge gaps in technical skills and workforce readiness. Developing an educational module that integrates specialty coffee processing into TVL curricula offers a strategic approach to enhancing students' competencies in agricultural entrepreneurship and food technology. By providing hands-on learning experiences, such a module can empower future farmers, entrepreneurs, and industry professionals while fostering an appreciation for local coffee heritage.

Developing educational programs that teach these techniques to young learners can empower the next generation of farmers and entrepreneurs (Adeyanju et al., 2023; Marope et al., 2015). It also aligns with the Philippine Department of Education's goal to enhance technical and vocational education by providing students with practical skills that meet local industry needs (Asian Development Bank, 2021; Edralin & Pastrana, 2023; Kilag et al., 2024; Metante & Metante, 2024). Given the global growth in coffee consumption and the specialty coffee market, equipping students with knowledge in coffee processing offers a promising approach to sustaining and advancing the regional coffee industry.

The focus on experiential learning within specialty coffee education aligns closely with Kolb's experiential learning theory, which posits that hands-on, practical experiences are essential for effective learning (McLeod, 2024). This theory suggests that when students are actively engaged in all stages of coffee production—from nursery management to processing and brewing—they develop a comprehensive understanding of the industry's complexities and essential skills. This approach is reinforced by the study of Chantarasombat et al. (2022) on the development and application of a learning module, "*Educational Policy and Strategic Plan Development of Students*," conducted at Northeastern University, Khon Kaen, during the academic year 2020.

Studies underscore the benefits of integrating context-specific, industry-aligned content in TVL education (Ann & Petancio, 2020; Espinas et al., 2020; Urrutia et al., 2019). Aligning educational programs with local industries increases student engagement and motivation, as they see a clear connection between their studies and potential career paths (Pellegrino & Hilton, 2012). In the case of coffee-producing regions, a module focused on specialty coffee processing allows students to acquire skills directly applicable to their community's economic context, fostering both practical knowledge and local pride. Through context-specific training, students are more likely to develop expertise that can support the local economy while meeting industry standards for quality. This approach also aligns with the goals of the Philippine K-12 curriculum, which emphasizes the importance of education that is both locally relevant and globally competitive (DepEd, 2012).

The ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) is a widely recognized instructional design framework that supports the systematic development of educational materials. The model has proven effective in technical education, providing a structure that ensures educational content aligns with student needs and industry standards (Handayani et al., 2023). Applying this model to develop a specialty coffee processing module enables a structured approach to addressing local educational gaps and enhancing the module's instructional quality. Furthermore, the ADDIE model supports continuous feedback and improvement, which is critical in Technical-Vocational-Livelihood (TVL) subjects where industry standards frequently evolve. Using the ADDIE model in module development enables educators to create educational materials that are not only informative but also adaptable to emerging trends and best practices within the industry. For specialty coffee processing, this adaptability ensures that educational content remains relevant and beneficial for students aiming to enter the workforce.

This study aims to develop a Specialty Coffee Processing Learning Module for high school students enrolled in the Technical-Vocational-Livelihood (TVL) strand, covering coffee processing techniques from "bean to cup," and then assess the developed module based on quality, student learning outcomes, retention, and learning satisfaction. The findings contribute to the literature on agricultural education, highlighting the potential of specialized modules in fostering skill development and supporting local industries.

2.0

3.0 Methodology

2.1 Research Design

This study employed a quantitative, descriptive-evaluative research design to develop and assess a Specialty Coffee Processing Learning Module for TVL high school students in the Palimbang District, Sultan Kudarat Province. The descriptive-evaluative approach was chosen to quantitatively evaluate the effectiveness, efficiency, and student satisfaction associated with the learning module. Using this approach allowed the researchers to gather comprehensive data on student learning outcomes, module quality, and knowledge retention.

2.2 Participants and Sampling Technique

The study employed purposive sampling to select participants for the module validation and evaluation phases. For the module validation, a total of 31 experts from relevant fields (agriculture, coffee processing, and education) provided feedback, ensuring the module met industry and educational standards. For the module pilot testing, Grade 7 TVL students from the Palimbang District were selected based on their enrollment in the TVL curriculum, which includes agricultural studies. This selection ensured that participants had the foundational knowledge necessary to engage meaningfully with the module content.

2.3 Development of the Specialty Coffee Processing Learning Module

The development of the specialty coffee processing module was guided by the ADDIE model, a widely recognized instructional design framework. This model includes five phases: Analysis, Design, Development, Implementation, and Evaluation (Handayani et al., 2023; Lumbantoruan & Ditasona, 2024): In the initial phase, a needs assessment was conducted to identify the educational requirements of high school students regarding coffee processing. This analysis involved document review, diagnostic testing, interviews, and focus group discussions with Grade 7 TVL teachers. The assessment identified specific knowledge gaps and skill requirements that guided the module's content and objectives.

Based on the needs assessment, the module was structured into five main lessons covering key aspects of specialty coffee processing, including coffee nursery management, propagation methods, plantation economics, specialty coffee processing techniques, and brewing methods. The module was designed to be engaging, interactive, and accessible, with learning activities and assessments embedded in each lesson to promote active learning. Considerations were given to content accuracy, organization, mechanics, and overall layout to ensure clarity and usability for high school students. The module content was developed iteratively, integrating feedback from experts in coffee production, agriculture, and education. Attention was given to technical accuracy, pedagogical soundness, and readability, ensuring that the module was both informative and student-friendly. An initial draft was created, which included theoretical information, practical activities, and assessments tailored to the specialty coffee processing field.

The preliminary version of the module underwent validation by a panel of experts, including five local coffee farmers, one municipal agriculturist, three coffee processing and farming trainers, two coffee quality graders and cuppers, and 15 TVL teachers. These validators assessed the module based on criteria such as content relevance, mechanics, organization, and overall instructional quality. Following expert review, the module was piloted with a group of Grade 7 TVL students, who also provided feedback on its clarity, engagement, and accessibility. The module was evaluated through multiple metrics, including pre- and post-tests to measure knowledge acquisition, a retention test administered two weeks after the post-test, and a satisfaction survey to measure student engagement and learning experience. The pre-test served as a baseline measure of student knowledge, while the post-test and retention test allowed for assessing immediate learning gains and retention over time. The student satisfaction survey, adapted from the Likert-based tool used in similar educational studies, assessed factors such as content clarity, engagement, organization, and overall satisfaction with the module.

2.4 Module efficiency and effectiveness

The efficiency and effectiveness of the "Specialty Coffee Processing" Learning Module were analyzed using mean values and percentages, following the method used by Chantarasombat and Rooyuenyong (2020). The efficiency (E) of the module was calculated using the formula, defined as follows:

$$E = E1/E2 \quad (1)$$

This formula evaluates the effectiveness of the learning module by considering both individual student scores and the frequency of achievement.

- E1 represents the efficiency of the learning module based on students' average scores. It is calculated by summing the individual scores of all students, dividing by the total number of students, and then multiplying by 100.
- E2 represents the efficiency based on the frequency of achievement. This is calculated by summing the frequencies of achievement, dividing by the total number of students, and then multiplying by 100.

The module's efficiency was calculated using the E1/E2 formula, which assesses both process efficiency (E1) and outcome efficiency (E2) by comparing student performance to target criteria. The target efficiency threshold was set at 80/80, meaning that both E1 and E2 should ideally meet or exceed this benchmark to demonstrate a high-quality learning experience.

The effectiveness index of learning through the "Specialty Coffee Processing" Learning Module was calculated using the following formula:

$$Effectiveness\ Index\ = \frac{\text{Sum of Post} - \text{test Score}\ -\ \text{sum of pretest score}}{(\text{Student Number X Full Score}) -\ \text{sum of pre test Score}} \quad (2)$$

This formula measures the module's overall effectiveness by comparing the total student gains from pre-test to post-test scores against the possible maximum score for the group. A higher effectiveness index indicates greater learning improvements across the cohort.

2.5 Learning retention

Learning retention for the "Specialty Coffee Processing" Learning Module was assessed by measuring students' performance over time. A dependent t-test was used to compare the mean scores from the pre-test and post-test, evaluating immediate learning gains. To assess retention, a follow-up test was administered two weeks after the post-test. The mean scores of the post-test and the two-week follow-up test were then compared using the t-test to determine if knowledge retention was sustained over this period (Chantarasombat & Rooyuenyong, 2020).

2.6 Student satisfaction and engagement

To assess students' satisfaction and engagement with the "Specialty Coffee Processing" Learning Module, an adapted instrument from Fabia (2024) was employed. Developed initially to evaluate "Students' satisfaction, self-efficacy, and achievement in an emergency online learning course," this instrument was modified to align with the context of the specialty coffee module. Student satisfaction levels were analyzed using mean (μ) and standard deviation (SD) values.

2.7 Data Analysis Procedure

Data were analyzed using descriptive and inferential statistics to provide a comprehensive evaluation of the module's effectiveness. The pre-test and post-test scores were analyzed using paired t-tests to determine whether there were significant improvements in student knowledge following the implementation of the module. A paired t-test was used to compare post-test and retention test scores, assessing the module's impact on long-term retention—descriptive statistics (mean and standard deviation) summarized responses from the satisfaction survey. Scores were interpreted based on established benchmarks to identify areas of high and low satisfaction.

2.8 Ethical Considerations

This study strictly adhered to the ethical guidelines outlined in the Belmont Report—specifically, the principles of beneficence, respect for human dignity, and justice—as well as the Declaration of Helsinki (World Medical Association, 2013), which governs ethical research involving human participants. All participants were provided with an Informed Consent Form that clearly stated the purpose, procedures, risks, benefits, and the voluntary nature of their participation. For students below the age of 18, parental or guardian consent was secured in addition to the students' assent. Participants were assured that their identity and personal information would remain confidential and anonymous. All data collected was stored securely and used exclusively for research purposes. Only the researchers had access to the data, which was coded to protect participants' identities.

Additionally, participants were informed of their right to withdraw from the study at any point without any repercussions. Throughout the research process, care was taken to ensure that no harm or discomfort would be caused to any of the participants, particularly the Grade 7 students involved in the pilot testing. The researchers also acknowledged the cultural and community contexts of the participants and ensured that local norms and sensitivities were respected throughout the study's conduct.

3.0 Results and Discussion

3.1 Quality of the Specialty Coffee Learning Module

Table 1 presents the expert validation results of the Specialty Coffee Processing Learning Module across four critical quality factors: Content Relevance and Appropriateness, Design and Presentation, Clarity and Organization, and Accuracy and Reliability. All factors received high mean scores, indicating a strong consensus among validators regarding the module's quality.

Table 1. *Experts' Validation of the Specialty Coffee Learning Module*

Factors	Mean	SD	Description	Interpretation
Content Relevance and Appropriateness	3.77	0.05	High Quality	Meets above 75-90% quality relevance
Design and Presentation	3.79	0.04	High Quality	Meets above 75-90% quality relevance
Clarity and Organization	3.77	0.05	High Quality	Meets above 75-90% quality relevance
Accuracy and Reliability	4.00	0.00	High Quality	Meets above 75-90% quality relevance

The module received a mean score of 3.77 ± 0.05, which falls within the high-quality range, indicating that the content is highly relevant and appropriate for its intended learners. This suggests that the module effectively addresses the key competencies and knowledge areas required for specialty coffee processing. The low standard deviation shows consistency in expert judgments, confirming the content's alignment with educational and industry standards. The high mean score suggests that the module effectively addresses the specific skills and knowledge required in coffee processing, which is crucial in vocational education as students need industry-relevant competencies to succeed (Handayani et al., 2023).

The design and presentation factor achieved a mean score of 3.79 ± 0.04; the module's design was rated as high quality. This factor covers elements such as font size, layout, and the quality of illustrations, which contribute to the readability and visual appeal of the material. The high rating indicates that the module was designed with attention to detail, making it accessible and visually engaging for students. Effective design is essential in technical modules (Abdulrahaman et al., 2020), as clear presentation helps students better understand complex processes in coffee production and processing. The clarity and organization factor also received a score of 3.77 ± 0.05. The high-quality rating for clarity and organization suggests that the module presents information in a logical sequence and uses language that is suitable for the target audience. Well-organized content and concise language facilitate students' ability to follow lessons and retain information, which is crucial for mastering technical subjects (Pashler et al., 2007). The low standard deviation reflects consistency among validators, indicating that they universally perceived the module as well-structured and easy to navigate.

Notably, the accuracy and reliability received a perfect mean score of 4.00 with a standard deviation of ± 0.00, suggesting that all expert validators unanimously agreed that the information in the module is accurate, up-to-date, and free from bias or misinformation. Accuracy is vital in vocational education, where students rely on precise information to develop practical skills that they can later apply in real-world settings (McGrath & Yamada, 2023). The high ratings across all factors (content relevance and appropriateness, design and presentation, clarity and organization, and accuracy and reliability) confirm that the Specialty Coffee Processing Learning Module is well-designed, relevant, and accurate, making it an effective tool for preparing high school students for practical roles in the coffee industry. The alignment of content with industry requirements, combined with accessible design and reliable information, makes this module a strong candidate for broader application in technical and vocational education programs.

3.2 Module Efficiency and Effectiveness

The findings in Table 2 indicate that the module achieved an efficiency score of 80.87/80.44, very close to the target threshold (80/80), demonstrating its strong effectiveness in delivering intended learning outcomes. This score indicates that the module effectively delivers its content within an optimal timeframe and supports student learning outcomes.

Table 2. *Efficiency of the Specialty Coffee Processing Learning Module*

Lesson Items	Lesson 1 (10)	Lesson 2 (10)	Lesson 3 (30)	Lesson 4 (25)	Lesson 5 (10)	Total Score (85)	Post test (50)
Mean	7.59	7.56	24.56	21.11	7.93	68.74	40.22
SD	1.12	1.25	3.08	2.14	1.04	3.19	5.06
Mean	75.93	75.56	81.85	84.44	79.26	**80.87(E1)**	**80.44(E2)**

Lesson 4: Understanding Specialty Coffee Processing recorded the highest efficiency mean score of 84.44, suggesting that students found this lesson particularly engaging and were able to absorb and retain its content efficiently. The lower standard deviation (SD = 2.14) indicates consistent performance among students in this lesson, likely due to its practical focus, which allowed students to engage with hands-on activities.

Lesson 3: Establishment of Coffee Robusta Plantation and Economics also scored high (μ = 81.85), with students responding well to content that connects practical agricultural skills with economic knowledge.

This link between technical skills and real-world applications contributed to the high efficiency score for this lesson, as students could see direct applications of the content. The slight variations in efficiency scores across lessons (ranging from 75.56 to 84.44) reflect differences in content complexity and student engagement with each topic. Lessons with higher complexity, such as Methods of Coffee Production and Coffee Brewing Methods, showed slightly lower efficiency scores (μ= 75.56 and μ=79.26, respectively), possibly due to the detailed processes involved in these topics. Nevertheless, all lessons met the quality threshold, confirming the module's success in providing a well-paced and practical learning experience.

In terms of effectiveness, Table 3 presents the module's learning impact, measured through pre-test and post-test scores, with the effectiveness index calculated to quantify the improvement in students' knowledge. The effectiveness index (EI) for the module was 0.7108 or 71.08%, indicating substantial gains in student knowledge and skills. This index represents the significant increase in knowledge that students gained from pre-test to post-test, with an average post-test score of 40.22,± 5.06, compared to a much lower pre-test baseline. The high effectiveness index aligns with findings in education research, where similar instructional modules have shown effectiveness indices in the 70-80% range, signifying robust learning gains (Chantarasombat & Rooyuenyong, 2020; Chantarasombat et al., 2022).

Table 3. *The Comparison of Scores Before and After the Intervention*

Test	Mean	SD	Mean Diff.	t	*P-value	Interpretation
Pre test	16.19	5.13	24.04	17.48	0.00	Significant
Post Test	40.22	5.06				

*Statistical significance level at $P < 0.05$

$$\text{Effectiveness Index (EI)} = \frac{1086-437}{(27\ x\ 50)-437}$$

$$\text{EI} = \frac{649}{1350 - 437} \qquad (3)$$

$$\text{EI} = \frac{649}{913}$$

EI= 0.7108 or 71.08%

The combination of high efficiency and effectiveness scores demonstrates that the module is not only well-designed in terms of structure and pacing but also successful in delivering substantial learning outcomes. These results suggest that the Specialty Coffee Processing Learning Module can serve as a model for other vocational education materials, providing a structured, engaging, and impactful approach to skill-based education in agricultural contexts.

3.3 Learning Retention

The data in Table 4 shows a slight increase in the mean score from the post-test (μ = 33.42) to the retention test (μ = 34.10), with a mean difference of 0.67. Although this difference is minimal, it suggests that students maintained or slightly enhanced their knowledge of specialty coffee processing concepts over the two weeks. The statistical analysis, with a *P*-value of 0.692, confirms that this change is not significant, supporting the conclusion that students' learning was retained effectively without substantial loss of information.

Table 4. *Students' Learning Retention after Completing the Learning Module*

Test	Mean	SD	Mean Diff.	df	t	P-value
Post test	33.42	9.17	0.67	48	0.399	0.692
Summative Test	34.10	9.31				

*Statistical significance level at $P < 0.05$

The results of learning retention of students who completed the Specialty Coffee Processing Learning Module suggest that the module effectively supported long-term knowledge retention, allowing students to retain core concepts of coffee processing, from nursery management to brewing techniques. Such retention is crucial in TVL education, as it demonstrates that students can retain practical knowledge that may benefit them in real-world applications. Studies have shown that modules designed with experiential and hands-on learning approaches, such as the ADDIE framework used in this module, tend to enhance both comprehension and retention (Chantarasombat et al., 2022; Handayani et al., 2023). This stable retention of learning outcomes suggests that the module's design was effective in reinforcing core concepts. The use of practical, hands-on activities likely contributed to students' ability to remember and apply what they learned, aligning with findings in educational research that highlight the role of experiential learning in improving long-term retention (McLeod, 2024). This result further validates the module's potential as an effective instructional tool in TVL education.

3.4 Student satisfaction and engagement

Student learning satisfaction with the Specialty Coffee Processing Learning Module was assessed using six key indicators: relevance and content, clarity and organization, engagement and interactivity, learning resources, overall learning experience, and overall student satisfaction. As shown in Table 5, the overall students' satisfaction achieved a mean score of 4.57 ± 0.06, interpreted as "Very High Extent", which corresponds to meeting a quality relevance of above 91–100%. This suggests that the module was perceived as highly satisfactory and effective in delivering quality educational experiences.

Table 5. *Students Learning Satisfaction*

Indicators	Mean	SD	Description	Interpretation
Relevance and Content	4.63	0.34	Very High Extent	Meets above 91-100% quality relevance
Clarity and Organization	4.62	0.36	Very High Extent	Meets above 91-100% quality relevance
Engagement and Interactivity	4.50	0.40	Very High Extent	Meets above 91-100% quality relevance
Learning Resources	4.50	0.40	Very High Extent	Meets above 91-100% quality relevance
Overall Learning Experience	4.60	0.38	Very High Extent	Meets above 91-100% quality relevance
Overall Students' Satisfaction	4.57	0.06	Very High Extent	Meets above 91-100% quality relevance

Among the individual indicators, relevance and content received the highest mean rating of 4.63 ± 0.34, also interpreted as "Very High Extent". This indicates that students found the module's content highly applicable to real-world coffee processing practices. Such relevance is crucial in technical and vocational education, where alignment with industry standards and practical competencies is essential. Clarity and organization followed closely with a mean of 4.62 ± 0.36, also rated to a very high extent. This reflects students' strong agreement that the module was well-structured, with clear objectives and logically arranged content, which facilitated ease of understanding and continuity of learning. The indicators of engagement, interactivity, and learning resources both received a mean score of 4.50 ± 0.40, each interpreted as "Very High Extent". These scores suggest that students appreciated the interactive components, such as quizzes and hands-on tasks, as well as the quality and accessibility of supplementary materials like videos, readings, and tools. These features likely enhanced learner motivation and supported diverse learning styles.

Lastly, the overall learning experience achieved a mean of 4.60 ± 0.38, reinforcing the positive perception of the module's overall impact. The consistently high ratings across all indicators confirm that the learning module met students' expectations and contributed significantly to their knowledge and skill development in specialty coffee processing. All indicators fell within the "Very High Extent" range, suggesting that the module meets and exceeds 91–100% quality relevance standards. These results affirm the module's effectiveness and its potential as a benchmark model for future curriculum development in vocational and technical education settings. Research in educational psychology emphasizes the importance of interactive learning, which enhances cognitive engagement by encouraging students to actively participate and apply what they have learned (Fadilah et al., 2020).

This high level of satisfaction indicates that the Specialty Coffee Processing Learning Module successfully addresses student needs for practical, clear, and engaging learning content, making it a valuable addition to TVL

education. The positive feedback on content clarity, organization, and resources reinforces the importance of designing modules that are not only educational but also engaging and accessible. The module's high engagement scores suggest that incorporating interactive elements, such as quizzes, discussions, and simulations, can help sustain student interest and improve understanding. Additionally, using culturally relevant examples and region-specific resources makes the module more relatable to students, as highlighted in previous studies on culturally responsive teaching (Gay, 2002; Urrutia et al., 2019; Ann & Petancio, 2020; Metante & Metante, 2024). This study contributes to the educational literature by validating the ADDIE model in developing practical, context-specific modules. The ADDIE framework's structured approach to designing, implementing, and evaluating the module allowed for the alignment of educational content with students' knowledge levels and industry needs. Additionally, the hands-on, experiential nature of the module aligns with Kolb's experiential learning theory, which posits that students acquire knowledge through active involvement in real-world tasks.

4.0 Conclusion

The Specialty Coffee Processing Learning Module, which has been implemented for high school students in the Palimbang District, Division of Sultan Kudarat, Philippines, has demonstrated outstanding quality, efficiency, effectiveness, retention, and student satisfaction, highlighting its strong potential as a model instructional tool in the field of Technical-Vocational-Livelihood (TVL) education. Expert validation confirmed that the module consistently meets high standards across all critical dimensions—content relevance, design, clarity, and accuracy, receiving an overall mean score of 3.83 out of 4.0. These findings validate the module's alignment with industry-relevant competencies essential for student preparedness in the coffee processing industry.

The results of efficiency and effectiveness further reinforce the module's pedagogical value. Exceeding the 80/80 benchmark and a substantial effectiveness index (71.08%), the module demonstrated its capability to deliver significant learning gains within an optimal time frame. The considerable increase in scores from pre-test to post-test highlights the module's effectiveness in imparting technical knowledge and skills. In terms of knowledge retention, students maintained their post-test performance levels two weeks after the test, with no significant decline observed. This confirms the module's success in promoting long-term learning, a critical factor in vocational education where sustained skill retention is key for future employment readiness. Student satisfaction data complement these outcomes, with all six indicators receiving ratings in the "Very High Extent", affirming the module's relevance, clarity, interactivity, and overall learning experience. The high engagement levels reflect the module's responsiveness to learner needs through interactive and culturally contextualized content, as well as its alignment with best practices in instructional design, such as the ADDIE framework and experiential learning principles.

The results provide robust corroboration that the specialty coffee processing learning module is a high-quality, learner-centered educational resource. It not only addresses the technical requirements of specialty coffee training but also fosters deep, lasting learning and student engagement. Therefore, the module is recommended for wider adoption and adaptation in TVL programs focused on agri-based enterprises, particularly in coffee-growing regions, to enhance workforce readiness and support sustainable local industry development.

5.0 Contribution of Authors

Cyril John A. Domingo: conceptualization and design, data analysis, approved final manuscript.
Lemuel Colis: data collection, analysis, interpretation of results, manuscript preparation.

6.0 Funding

Not applicable.

7.0 Conflict of Interest

The authors declare that they have no conflict of interest.

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