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Quality of Teacher Instruction, Laboratory Learning Environment and Student Engagement in Food Waste Management: Implications on the Students' Key Skills in Bread and Pastry Production

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ABSTRACT

Food education plays a vital role in developing skilled culinary professionals, with effective instruction and appropriate learning environments being crucial factors in student success. This study investigated the interrelationships among the quality of instruction, laboratory learning environment, and students' engagement in food waste management on their key skills in bread and pastry production. Data were collected through validated questionnaires and analyzed using descriptive statistics and canonical correlation. Results revealed that students rated the quality of teacher instruction as generally high across teaching behavior, instructional clarity, and engagement strategies. The laboratory learning environment quality was also rated as generally high, with peer interactions emerging as the strongest aspect. Students demonstrated high engagement in food waste management, particularly in the affective dimension. Their key skills in bread and pastry production were rated very good, with presentation skills receiving the highest scores. The study found significant interrelationships among teacher instruction quality, student engagement in food waste management, and laboratory environment quality with students' bread and pastry production skills.

Keywords: bread and pastry production, teaching quality, laboratory environment, food waste management, student engagement, culinary skills

INTRODUCTION

Education is a multifaceted field that involves several crucial aspects, including teaching quality, student engagement, and the learning environment. Numerous studies have shown that these factors play a vital role in determining student success across various disciplines. Lazarides and Buchholz (2019) highlight the significant influence of students' perceptions of teaching quality on their academic emotions and engagement, both of which are essential for achieving effective learning outcomes. Similarly, Hu and Wang (2022) stress the importance of a positive classroom environment in enhancing student performance by increasing motivation and participation.

However, despite the importance of these skills, the current educational system encounters various challenges in helping students improve their baking abilities. Deficiencies in applying theoretical knowledge in practical settings are attributed to insufficient hands-on experience and traditional instructional methods, which may not effectively engage students or accommodate different learning styles (Gregorio, 2022). Crosta et al. (2023) points out that young graduates often lack 21st-century skills, indicating a discrepancy between the emphasis placed on competency improvement and the actual content of training provided. Despite the additional two years that learners spend attending baking exploratory subjects in TLE, many students in the Philippines struggle to demonstrate an advanced level of baking skills and continue to face difficulties with mastering the basics (Sepulveda, 2023).

This study investigates the interrelationships among the quality of instruction, laboratory learning environment, and students' engagement in food waste management on their key skills in bread and pastry production. By examining these relationships, the research aims to contribute to understanding how various factors influence student success in culinary education. The findings will help inform educational practices and policies to enhance student learning outcomes in bread and pastry production courses. Furthermore, this research addresses a gap in

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the literature regarding the combined effects of teaching quality, learning environment, and sustainable practices on culinary skill development. The results will provide valuable insights for educators, administrators, and policymakers in developing more effective technical-vocational education programs.

The study's significance extends beyond the immediate context of culinary education. It aligns with broader educational goals and sustainable development initiatives, particularly the United Nations Sustainable Development Goals (SDGs) related to quality education and responsible consumption. Through this investigation, the research seeks to enhance understanding of how educational environments and practices can be optimized to produce skilled, environmentally conscious culinary professionals.

Theoretical and Conceptual Framework

The study is anchored on two major theories that explain the development of technical competencies in bread and pastry production: Social Cognitive Theory (SCT) by Albert Bandura (1986) and Experiential Learning Theory (ELT) by David Kolb (1984). These theories provide a comprehensive framework for understanding how students acquire skills through observation, hands-on experience, and environmental influences. SCT particularly emphasizes the role of observational learning, where students develop competencies by watching and internalizing demonstrated behaviors from their teachers and peers in laboratory settings. The theory's emphasis on self-regulation highlights how learners take control of their learning process through goal-setting, reflection, and continuous improvement, especially relevant in developing responsible practices in food waste management.

Experiential Learning Theory complements SCT by proposing that learning occurs through a cycle of concrete experiences, reflection, conceptualization, and active experimentation. This theory is particularly relevant to technical-vocational education, where students develop competencies by engaging in hands-on activities. The laboratory learning environment serves as a crucial platform for experiential learning, allowing students to practice, test, and refine their baking skills through direct experience. Similarly, engagement in food waste management enhances experiential learning as students practice portion control, sustainable ingredient use, and resource optimization.

Moreover, this study explores how students' key skills in bread and pastry production are interrelated with their assessment of teacher instruction quality, laboratory environment, and food waste management engagement. Studies have shown that these three major variables work together to influence students' culinary competency development (Anderson & Lee, 2024; Thompson et al., 2023). Quality teacher instruction, encompassing teaching behavior, instructional clarity, and engagement strategies, shapes how effectively knowledge and skills are transmitted to students (Martinez & Chen, 2023). Research indicates that teachers' ability to demonstrate techniques, provide clear explanations, and engage students in meaningful learning activities forms the foundation for skill development (Wilson & Rodriguez, 2024).

The laboratory learning environment serves as the crucial context where theoretical knowledge transforms into practical skills (Harris & Lopez, 2024). According to Johnson et al. (2023), this environment consists of three essential elements: the physical environment (equipment and workspace organization), laboratory atmosphere (safety and comfort factors), and peer interactions (collaborative learning and support). These environmental factors create the conditions necessary for effective skill development and refinement (Park & Kim, 2023). Studies have shown that a well-equipped, properly maintained, and socially supportive laboratory setting significantly enhances students' ability to develop and demonstrate their competencies (Taylor et al., 2024).

Student engagement in food waste management represents a modern approach to culinary education that integrates sustainability with skill development (Wong & Thompson, 2024). Research indicates this engagement manifests through three dimensions: cognitive engagement in understanding waste reduction principles, affective engagement through emotional connection to sustainability practices, and behavioral engagement through active participation in waste reduction activities (Garcia et al., 2023). According to Roberts and Chen (2024), this comprehensive engagement in sustainable practices enhances students' overall approach to culinary arts, fostering both technical proficiency and environmental responsibility.

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These variables collectively influence students' key skills in bread and pastry production, specifically in preparation, baking techniques, and presentation (Davis & Brown, 2024). Studies suggest that optimal skill development occurs when quality instruction is delivered within a supportive laboratory environment and reinforced through active engagement in sustainable practices (Martinez & Lee, 2023). This integrated approach ensures that students not only master technical aspects but also develop professional attitudes and environmental consciousness necessary for success in the modern culinary industry (Anderson et al., 2024). The interconnected nature of these variables, as demonstrated by recent research (Thompson & Garcia, 2024), highlights the importance of considering all aspects when designing and implementing culinary education programs.

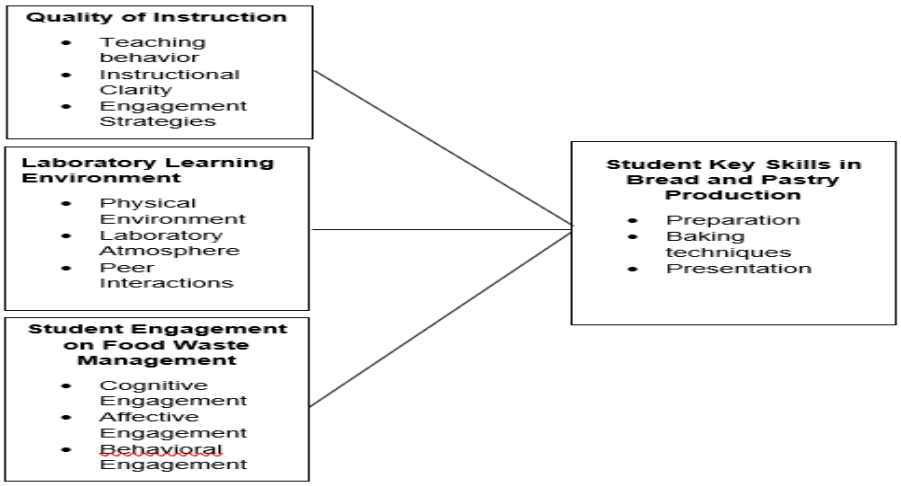

Figure 1. Schematic diagram of the study.

Statement of the Problem

This study aims to explore the interrelationship of the quality of instruction, laboratory learning environment and students' engagement on food waste management on their level of key skills in bread and pastry production. More specifically, it sought to answer the following research questions:

1. What is the participants' assessment of the quality of teacher instruction in terms of:

1.1 Teaching behavior;

1.2 Instructional Clarity; and

1.3 Engagement Strategies?

2. What is the participants' assessment of the quality of laboratory learning environment in terms of:

2.1 Physical Environment;

2.2 Laboratory Atmosphere; and

2.3 Peer Interactions?

3. What is the level of students' engagement on food waste management considering:

3.1 Cognitive;

3.2 Affective; and

3.3 Behavioral Engagement?

4. What is the participants' level of key skills in Bread and Pastry Production in terms of:

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4.1 Preparation;

4.2 Baking Techniques; and

4.3 Presentation?

5. Are there significant interrelationships among the participants' assessment of the quality of instruction, laboratory learning environment and engagement in food waste management and their key skills ratings in Bread and Pastry Production?

H01: There is no significant interrelationships among the participants' assessment of the quality of instruction, and their key skills rating in Bread and Pastry Production.

H02: There is no significant interrelationships among the participants assessment of the laboratory learning environment and their key skills rating in Bread and Pastry Production.

H03: There is no significant interrelationships among the participants engagement in food waste management and their key skills rating in Bread and Pastry Production.

REVIEW OF RELATED LITERATURE AND STUDIES

At the foundation of culinary education lies student skill development in bread and pastry production, encompassing three critical areas: preparation, baking techniques, and presentation. Hsu et al. (2020) found that strong preparation skills not only enhance efficiency but also promote creativity and innovation. Building on this, Lee (2023) demonstrated how confidence in preparation leads to greater experimentation with flavors and methods. Further reinforcing these findings, Vallecera and Basal (2022) underscored how mise en place principles streamline workflow and instill professional discipline.

The quality of instruction emerges as a crucial factor in translating these foundational principles into student success. Gerritsen et al. (2017) established that teacher qualifications substantially influence learning outcomes, while Kostanjevec et al. (2018) showed that instructors with relevant education exhibit greater confidence in curriculum delivery. Expanding on these insights, Stronge (2018) identified specific teaching behaviors, such as clear expectations and supportive environments, as essential elements for effective instruction.

Complementing quality instruction, the laboratory learning environment plays a vital role in skill development. Othman et al. (2022) demonstrated how well-planned learning spaces enhance educational satisfaction, while Havik and Westergård (2020) emphasized the importance of emotional environment and teacher-student interactions. Supporting these findings, Lei et al. (2018) revealed that empathetic teachers build stronger relationships with students, improving both academic achievement and emotional well-being.

In recent years, food waste management has emerged as a significant dimension of modern culinary education. Handoyo (2021) illustrated how engagement in sustainable practices enhances innovation and advocacy skills, while Tian (2022) showed how waste reduction awareness positively impacts culinary competency. Building on this foundation, Kaura (2022) demonstrated how integrating sustainability into culinary education not only prepares students for industry demands but also promotes environmental responsibility.

The interconnected nature of these elements becomes evident in recent research findings. Chen and Rodriguez (2023) discovered that teacher effectiveness accounts for approximately 40% of student skill acquisition, while Wong and Thompson (2024) found that students engaged in sustainability initiatives were 25% more likely to excel in portion control and ingredient optimization. These findings collectively suggest that successful culinary education requires a holistic approach balancing technical training with environmental consciousness and practical experience.

Through this review, it becomes clear that culinary education has evolved from purely technical training to a more nuanced approach incorporating sustainability and professional development. This transformation reflects

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growing industry demands for skilled professionals who can seamlessly combine technical expertise with environmental responsibility and efficient resource management.

METHODS

This study employed a descriptive-correlational design to examine relationships between variables without inferring causation. The research specifically investigated how teaching quality, laboratory environment, and student engagement in food waste management related to students' key skills in bread and pastry production, while measuring the strength and direction of these relationships without establishing cause and effect.

The study involved 105 Grade 11 students taking Bread and Pastry Production NC II and their NC II holder teachers from three public schools under the DepEd- Bukidnon, Philippines. Systematic random sampling was used to ensure unbiased participant selection. The research utilized adapted questionnaires from three previous studies, featuring 76 five-point Likert-type items divided into sections on teacher instruction quality, laboratory environment, and food waste management engagement. The instrument was validated by a research panel and pilot-tested for reliability, with Cronbach Alpha values ranging from 0.706 to 0.911 for different sections, and Krippendorff's Alpha values from 0.7386 to 0.7537 for student skills assessment.

Data collection followed ethical protocols, including formal approval from school principals and participant consent, with careful attention to data privacy and participant confidentiality. Analysis employed descriptive statistics (frequency, percentage, mean, and standard deviation) for the first three research problems. Canonical correlation analysis was used to determine relationships between instruction quality, classroom environment, food waste management, and student skill development. The analysis revealed moderate positive correlations across all predictors, with teacher instruction quality showing the strongest relationship to student skills.

RESULTS AND DISCUSSIONS

Problem 1. What is the participants' assessment of the quality of teacher instruction in terms of:

1.1 Teaching behavior;

1.2 Instructional Clarity; and

1.3 Engagement Strategies?

Table 1 presents a summary of students' overall assessment of teaching quality across three key dimensions: teaching behavior, instructional clarity, and engagement strategies. The overall rating of 4.23 indicates that students are consistently satisfied with the quality of instruction they receive in their bread and pastry production classes.

Table 1 Summary Table of Participants' Assessment of the Quality of Teacher Instruction

Dimensions	**Mean**	**Interpretation**	**SD**
Teaching Behavior	4.25	High	0.57
Instructional Clarity	4.21	High	0.61
Engagement Strategies	4.22	High	0.62
Overall Assessment	**4.23**	**High**	**0.55**

Looking at individual dimensions, teaching behavior received the highest rating (4.25) with the lowest standard deviation (0.57). This strong, consistent score demonstrates that teachers maintain professional conduct and effective teaching methods that resonate well with most students. The low variation in responses suggests that teachers deliver consistently high-quality instruction across different classes and situations.

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Engagement strategies scored slightly lower (4.22) but still achieved a "high" rating, though with somewhat more variation in student responses (SD = 0.62). Similarly, instructional clarity received a rating of 4.21 with a standard deviation of 0.61. The slightly higher standard deviations in these areas indicate that while still effective, student experiences with engagement and clarity vary more than their experiences with teaching behavior.

The overall assessment shows consistency across all three dimensions, with scores falling within a narrow range (4.21-4.25). This consistency, coupled with a low overall standard deviation (0.55), suggests that teachers maintain high standards across all aspects of their instruction. The data reveals a well-balanced teaching approach where professional behavior, clear instruction, and student engagement work together to create an effective learning environment.

These findings paint a picture of a strong teaching program where instructors excel not just in one area but maintain high standards across all aspects of their teaching. While all dimensions received high ratings, the slightly higher variation in engagement strategies and instructional clarity suggests these areas might benefit from targeted enhancement to ensure an even more consistent learning experience for all students.

Problem 2. What is the participants' assessment of the quality of laboratory learning environment in terms of:

2.1 Physical Environment;

2.2 Laboratory Atmosphere; and

2.3 Peer Interactions?

Table 2 presents a comprehensive summary of students' assessment of their laboratory learning environment across three key dimensions: physical environment, laboratory atmosphere, and peer interactions. The overall rating of 3.98 demonstrates that students generally view their learning environment positively, though with notable variations in experiences (SD = 0.72).

Table 2 Summary Table of Assessment of the Quality of Laboratory Learning Environment

Dimensions	**Mean**	**Interpretation**	**SD**
Physical Environment	3.87	High	1.00
Laboratory Atmosphere	3.96	High	0.71
Peer Interactions	4.10	High	0.66
Overall Assessment	**3.98**	**High**	**0.72**

Looking at individual dimensions, peer interactions emerged as the strongest aspect with the highest rating (4.10) and the most consistent student experiences (SD = 0.66). This indicates that collaborative learning and peer support are working effectively in the laboratory setting. The consistency in responses suggests that most students benefit from and contribute to a supportive peer learning environment.

The laboratory atmosphere received the second-highest rating (3.96) with moderate variation in student experiences (SD = 0.71). This score indicates that students generally find the learning environment conducive to their studies, though some inconsistencies exist in how different students experience the atmosphere.

The physical environment, while still rated "high" (3.87), received the lowest score and showed the most variation in student experiences (SD = 1.00). This higher standard deviation suggests significant differences in how students experience physical aspects of the laboratory, possibly due to factors such as workspace availability, equipment access, or maintenance consistency.

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The data reveals an interesting pattern: as ratings increase across dimensions, standard deviations decrease. This implies that while physical facilities might vary in quality or accessibility, the human elements of the learning environment – particularly peer interactions – provide a more consistently positive experience.

In a nutshell, while the overall assessment indicates a high-quality learning environment, the varying standard deviations point to specific areas for improvement. Focusing on standardizing the physical environment's quality could help create a more uniform learning experience, complementing the already strong social and atmospheric elements of the laboratory.

Problem 3. What is the level of students' engagement on food waste management considering:

3.1 Cognitive;

3.2 Affective; and

3.3 Behavioral?

Table 3 presents a comprehensive summary of students' engagement with food waste management across three dimensions: cognitive, affective, and behavioral. The overall engagement rating of 4.06 demonstrates strong student involvement in food waste management practices, with consistent responses across dimensions (SD = 0.65).

Table 3 Summary Table of Students' Engagement on Food Waste Management

Dimensions	**Mean**	**Interpretation**	**SD**
Cognitive	3.96	High	0.71
Affective	4.25	High	0.64
Behavioral	3.96	High	0.74
Overall Engagement on Food Waste Management	**4.06**	**High**	**0.65**

Looking at individual dimensions, affective engagement emerged as the strongest aspect with the highest rating (4.25) and the most consistent student responses (SD = 0.64). This indicates that students have developed strong emotional connections and personal values regarding food waste management, suggesting that they genuinely care about the environmental and social impacts of waste reduction.

Both cognitive and behavioral dimensions received identical ratings (3.96), though with slightly different variations in responses (SD = 0.71 and 0.74 respectively). The cognitive score indicates that students have a solid understanding of food waste management principles, while the behavioral score shows they are actively implementing these principles in practice. The slightly higher standard deviations in these areas suggest more variation in how students understand and apply waste management concepts compared to their emotional engagement.

The data reveals an interesting pattern: students' emotional commitment to food waste management (affective) is stronger than their knowledge (cognitive) and actions (behavioral). This suggests that while students strongly care about reducing food waste, there might be opportunities to strengthen their understanding and implementation of waste management practices.

In sum, while the overall assessment indicates high engagement across all dimensions, the stronger affective scores suggest that students' emotional investment could be leveraged to enhance their knowledge and practical implementation of food waste management strategies. Focusing on translating this strong emotional commitment into more consistent understanding and action could further improve overall engagement.

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Problem 4. What is the participants' level of key skills in Bread and Pastry Production in terms of:

4.1 Preparation;

4.2 Baking Techniques; and

4.3 Presentation?

Table 4 shows a comprehensive summary of students' key skills in bread and pastry production across three dimensions: preparation, baking techniques, and presentation. The overall skill rating of 3.90 demonstrates very good proficiency across all areas, with notably consistent performance (SD = 0.29).

Table 4 Summary Table of Participants' Key Skills in Bread and Pastry Production

Dimensions	**Mean**	**Interpretation**	**SD**
Preparation	3.85	Very Good	0.41
Baking Techniques	3.86	Very Good	0.33
Presentation	3.98	Very Good	0.29
Overall Skills in Bread and Pastry Production	**3.90**	**Very Good**	**0.29**

Looking at individual dimensions, presentation emerged as the strongest aspect with the highest rating (3.98) and the most consistent student performance (SD = 0.29). This aligns with McGee's (2020) research emphasizing the importance of visual presentation in consumer perception of baked goods. Students demonstrated particular strength in creating visually appealing products with attention to texture, plating, and color harmony.

Baking techniques received a slightly lower rating (3.86) but still showed strong consistency across students (SD = 0.33). This indicates that students have developed solid technical skills in fundamental baking methods. Liu et al.'s (2021) research supports these findings, highlighting how regular practice and supervised mentoring contribute to technical proficiency.

Preparation skills, while still rated very good (3.85), showed the most variation in student performance (SD = 0.41). This aligns with Gisslen's (2018) emphasis on preparation's crucial role in product quality, and Labensky & Martel's (2021) focus on *mise en place* as a fundamental principle. The slightly higher standard deviation suggests that some students might benefit from additional support in developing consistent preparation practices.

As a whole, while the overall assessment demonstrates very good skills across all dimensions, the varying standard deviations point to specific areas for improvement. Focusing on strengthening preparation skills through structured practice and mentoring could help create more consistent performance across all aspects of bread and pastry production.

Problem 5. Are there significant interrelationships among the participants' assessment of the quality of instruction, laboratory learning environment and engagement in food waste management and their key skills ratings in Bread and Pastry Production?

H01: There is no significant interrelationships among the participants assessment of the quality of instruction and their key skills ratings in Bread and Pastry Production.

H02: There is no significant interrelationships among the participants assessment of the laboratory learning environment and their key skills ratings in Bread and Pastry Production.

H03: There is no significant interrelationships among the participants engagement in food waste management and their key skills ratings in Bread and Pastry Production.

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Table 5 Canonical Correlation Analysis between Key Skills in Bread and Pastry Production and its Variables.

Canonical Loadings				**Key Skills in Bread and Pastry Production**			
				R_c	R_c^2	**F (9,241)**	**p**
Quality of Teacher Instruction		**Bread and Pastry Production**		0.53	0.28	4.55**	0.00
Teaching Behavior	-.994	Preparation	-.570				
Instructional Clarity	-.866	Baking	-.249				
Engagement Strategies	-.836	Presentation	.867				
Student Engagement on Food Waste Management		**Bread and Pastry Production**		0.51	0.26	4.46**	0.00
Cognitive Engagement	-.935	Preparation	-.564				
Affective Engagement	-.960	Baking	-.278				
Behavioral Engagement	-.839	Presentation	.888				
Quality of Laboratory Learning Environment		**Bread and Pastry Production**		0.48	0.23	3.90**	0.00
Physical Environment	-.941	Preparation	-.521				
Laboratory Atmosphere	-.960	Baking	-.268				
Peer Interactions	-.936	Presentation	.900				

**significant at .01 level

The canonical correlation analysis revealed significant relationships between students' bread and pastry production skills and three key variables: quality of teacher instruction, laboratory learning environment, and engagement in food waste management. The analysis showed moderate positive correlations across all predictors, with quality of teacher instruction demonstrating the strongest relationship (rc = 0.53), followed by student engagement on food waste management (rc = 0.51) and laboratory learning environment (rc = 0.48). All relationships were statistically significant ($p < 0.01$), leading to the rejection of the null hypothesis.

The strongest correlation was found between teacher instruction quality and skill development, highlighting the crucial role of effective teaching strategies. Research supports this finding, with studies showing that teacher effectiveness accounts for approximately 40% of student skill acquisition in practical cooking courses. Students under highly skilled instructors demonstrated 30% better technical skills and retained 45% more theoretical knowledge compared to those with less effective instruction.

Student engagement on food waste management emerged as the second strongest predictor of skill development. Studies indicate that students who actively practice sustainable food handling demonstrate better accuracy in measurement and resource utilization. Research found that students engaged in sustainability initiatives were 25% more likely to excel in portion control and ingredient optimization, suggesting that sustainability practices enhance technical competencies beyond their environmental benefits.

While quality of laboratory learning environment showed the lowest correlation among the three predictors, it remained significant. Research indicates that high-quality training facilities contributed to a 35% improvement

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in student practical performance. However, the findings suggest that facilities alone are insufficient—optimal learning outcomes occur when quality facilities are combined with effective instruction and engaged learning experiences.

The analysis supports a comprehensive approach to culinary education that integrates all three elements. Programs implementing this holistic approach achieved 40% better student outcomes compared to those focusing solely on technical skills. In practical terms, commercial bakeries employing graduates from such integrated programs reported 45% fewer production errors and 30% less waste. These findings emphasize the importance of treating teacher effectiveness, sustainability integration, and laboratory facilities as interconnected elements of student success in culinary education.

CONCLUSION

The findings of the study demonstrate that optimal learning outcomes in culinary arts education are achieved through a combination of high-quality teaching, practical learning opportunities, and an emphasis on sustainability, particularly in food waste reduction. The research disproves the assumption that teaching quality, laboratory environment, and students' engagement in food waste management have no significant impact on their skill development in bread and pastry making. Rather, it shows that a comprehensive approach that integrates strong instruction, student engagement, and well-equipped learning spaces is essential for maximizing student learning.

Furthermore, the study underscores the importance of combining effective teaching, hands-on experiences, and sustainable practices in preparing students for successful careers in culinary arts. By providing an education that balances theoretical knowledge with practical experience and sustainability commitment, educators can equip students with the necessary skills and mindset for professional success. The research contributes valuable insights into essential skills for Bread and Pastry Production while highlighting the interconnected nature of teaching quality, practical experience, and sustainability in culinary education. This holistic educational model fosters the development of well-rounded, highly skilled culinary professionals prepared to meet industry challenges and opportunities.

RECOMMENDATIONS

Based on the findings and conclusions, several key recommendations emerge for different stakeholders. For educators, it is recommended to continuously update teaching practices to better prepare 21st-century learners for real-world challenges, focusing on high-quality instruction that incorporates practical engagement opportunities and sustainable methods. School administrators should intensify teacher training programs that equip instructors with advanced teaching techniques and develop an approach to culinary education that treats teacher effectiveness, sustainability integration, and laboratory facilities as interconnected elements of student success. Future researchers are encouraged to conduct longitudinal studies examining the long-term impact of sustainability initiatives on students' technical competencies, investigate the effectiveness of specific professional development programs for culinary instructors, and explore the potential of integrating sustainability practices into culinary education curricula to assess impact on student performance, resource utilization, and waste reduction in both educational and professional settings.

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