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A study of learning achievement using pre- and post-unit tests in an ornamental plant production course among vocational certificate students

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Abstract

This classroom action research aimed to examine the effects of using pre-tests and post-unit tests on students' learning achievement and practical skill development in Learning Units 4 and 5 of the Ornamental Plant Production course. The participants were 22 vocational certificate students enrolled in an agricultural program at Ratchaburi College of Agriculture and Technology during the first semester of the 2025 academic year. The research instruments consisted of achievement tests administered before instruction and at the end of each learning unit, as well as a rubric-based practical skill assessment. Content validity of the instruments was verified by three experts using the Index of Item–Objective Congruence, and reliability analysis yielded a Cronbach's alpha coefficient of .92. Quantitative data were analyzed using paired-samples t-tests to compare pre-test and post-test scores, while descriptive statistics were used to examine students' practical skill levels. The results revealed that students' post-test achievement scores in both learning units were significantly higher than their pre-test scores at the .05 level. In addition, most students demonstrated high levels of practical skills, with the majority achieving Very Good to Excellent performance levels. These findings indicate that integrating systematic pre-tests and post-unit tests can effectively enhance learning continuity, reinforce conceptual understanding, and support the development of practical competencies in vocational agricultural education. The instructional approach provides practical implications for teachers seeking to improve formative assessment practices and student-centered learning in similar vocational contexts.

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Introduction

Ornamental plant production is a fundamental subject in agricultural education aimed at developing students' knowledge, understanding, and practical skills in plant cultivation, maintenance, and systematic crop management. The course covers essential content including the economic and social importance of ornamental plants, plant classification, factors affecting plant growth, horticultural tools and materials, basic cultivation techniques, and plant care practices. These competencies form a critical foundation for further professional development and future careers in agriculture and horticultural entrepreneurship (Office of the Vocational Education Commission [OVEC], 2023; FAO, 2022).

Contemporary educational approaches emphasize learner-centered instruction, active engagement, experiential learning, and the development of higher-order thinking and vocational competencies. Students are encouraged to actively participate in both classroom and field-based activities to construct knowledge through authentic learning

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experiences (Ministry of Education, 2022; OECD, 2021). However, in vocational agricultural classrooms, particularly in theoretical components of ornamental plant production courses, many students demonstrate limited continuity of learning due to insufficient review of previously learned content. As a result, students often struggle to connect prior knowledge with new learning tasks, leading to increased instructional time spent on repetition and reduced opportunities for hands-on practice, which is essential for skill development in vocational education.

The use of pre-tests and post-tests serves as an effective instructional and assessment strategy to promote students' preparedness, self-regulated learning, and cognitive engagement. Pre-tests help diagnose students' prior knowledge and motivate them to review relevant content before instruction, while post-tests provide evidence of learning outcomes and reinforce knowledge consolidation. Moreover, assessment data enable instructors to adjust instructional strategies and optimize learning activities based on learners' actual performance levels (Black & Wiliam, 2018; Hattie, 2020). Empirical studies consistently indicate that systematic formative assessment and the use of pre- and post-testing significantly enhance learning achievement, learning continuity, and student motivation (OECD, 2021; Panadero et al., 2019).

Within the framework of classroom action research, the systematic use of assessment tools plays a vital role in addressing real instructional problems, supporting reflective teaching practices, and promoting continuous improvement in learning quality. Action research emphasizes collaborative problem-solving between teachers and students and focuses on context-specific interventions that enhance learner development in authentic classroom environments (Kemmis et al., 2014; Wongwanich, 2021). Achievement tests are commonly used to measure students' academic knowledge, skills, and learning attainment in relation to defined instructional objectives (Rittiroung, 2002). Accordingly, this study aims to investigate the development of students' learning achievement through the use of pre-tests and post-unit tests in Learning Units 4 and 5 among second-year vocational certificate students enrolled in the Ornamental Plant Production course at Ratchaburi College of Agriculture and Technology. The study seeks to address issues related to insufficient learning continuity, enhance students' responsibility for content review, and improve the effectiveness of practice-oriented instructional activities in vocational agricultural education.

Conceptual Framework of the Research

Based on a review of learning theory and formative assessment principles, the use of pre-tests and post-unit tests has been widely recognized as an effective strategy for enhancing learning readiness, promoting continuity of learning, and providing concrete evidence of students' learning achievement. Therefore, this study establishes a conceptual framework focusing on the causal relationship between instruction using pre-tests and post-unit tests (independent variable) and students' learning achievement in Learning Units 4 and 5 (dependent variable). This framework serves as a guideline for research design, data collection, and systematic data analysis.

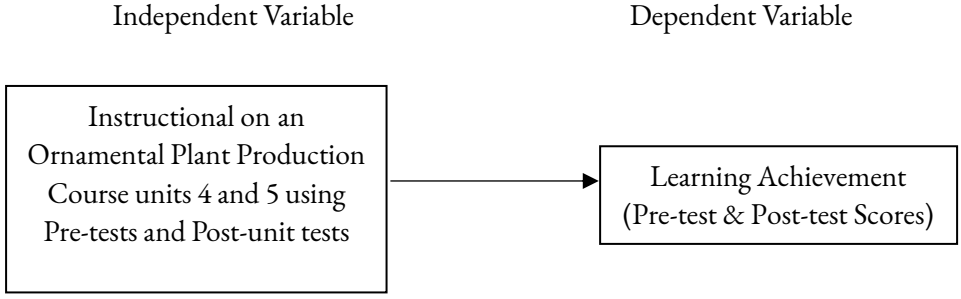

Figure 1. Conceptual Framework of the Research

Research Hypotheses

H1: Students' learning achievement in Learning Units 4 and 5 of the Ornamental Plant Production course after instruction using pre-tests and post-unit tests is significantly higher than before instruction at the .05 level.

H2: Students demonstrate high levels of practical skills after instruction using pre-tests and post-unit tests, as measured by rubric-based performance assessment.

Objectives

To examine the development of learning achievement of second-year vocational certificate students in the Ornamental Plant Production course using pre-tests and post-unit tests in Learning Units 4 and 5.

Method

Research Design

This study employed a classroom action research approach using a one-group pretest–posttest experimental design to examine the effectiveness of pre-tests and post-unit tests on students' learning achievement. The intervention integrated systematic formative assessment at the beginning of each lesson and summative assessment at the end of each learning unit. This design is appropriate for instructional improvement in authentic classroom contexts and supports continuous reflection and pedagogical refinement (Kemmis et al., 2014; Wongwanich, 2021).

Participants

The participants consisted of 22 second-year vocational certificate students enrolled in the Ornamental Plant Production course at Ratchaburi College of Agriculture and Technology during the first semester of the 2025 academic year. Purposive sampling was applied because the researcher was the course instructor and aimed to directly improve instructional practice in this classroom setting. All participants completed the full sequence of learning activities and assessments.

Research Instruments

Achievement Tests

Two sets of achievement tests were developed by the researcher to assess students' knowledge in the following learning units: (1) Learning Unit 4: Factors Affecting Ornamental Plant Growth, and (2) Learning Unit 5: Horticultural Materials, Tools, and Equipment. Each unit included multiple pre-tests administered at the beginning of selected lessons (four pre-tests for Unit 4 and three pre-tests for Unit 5). Each pre-test was scored on a 40-point scale, and one post-unit test was administered at the completion of each unit using the same scoring criteria. The tests consisted primarily of open-ended questions designed to assess students' conceptual understanding, factual accuracy, and ability to apply horticultural knowledge in practical contexts. In addition, students' practical skills were evaluated using a five-level scoring rubric, with classroom teachers serving as assessors. The rubric employed five performance levels (5, 4, 3, 2, and 1) and consisted of two assessment components: (1) Process Performance, and (2) Product Quality, with each component allocated 25 points, resulting in a total score of 50 points. Performance levels were interpreted as follows:

45 – 50 points: Excellent
37 – 44 points: Very Good
29 – 36 points: Good
21 – 28 points: Fair
Below 21 points: Needs Improvement

This rubric enabled systematic and consistent evaluation of students' practical competencies during hands-on learning activities.

Score Recording Forms

Structured score recording forms were used to systematically collect and organize individual students' pre-test and post-test scores for subsequent statistical analysis.

Instrument Validation and Quality Assurance

Content Validity

The achievement tests were reviewed by three subject-matter experts in agricultural education and educational measurement to evaluate content relevance, clarity, and alignment with learning objectives. The Index of Item–Objective Congruence (IOC) method was applied, with each item rated on a three-point scale (-1 = incongruent, 0 = uncertain, +1 = congruent). The IOC values ranged from 0.60 to 1.00, exceeding the acceptable threshold of 0.50 and indicating satisfactory content validity for all test items (Rovinelli & Hambleton, 1977). Minor wording revisions were

implemented based on expert feedback prior to classroom administration. Item discrimination indices ranged from 0.35 to 0.93, demonstrating good to excellent discriminating power. The internal consistency reliability of the achievement tests was examined using Cronbach's alpha coefficient, yielding a reliability value of $\alpha = 0.92$, which indicates a high level of measurement reliability.

In addition, students' practical skills were assessed using a five-level scoring rubric. The rubric was evaluated by experts for content validity and coverage of practical skill competencies using the IOC method. The rubric was subsequently pilot-tested with a group of students who were not part of the research sample to examine clarity, feasibility, and usability. Revisions were made based on pilot feedback before final implementation in the study.

Scoring Consistency and Reliability Control

All tests were scored using an analytic rubric with four performance levels (0–3 points per response), emphasizing accuracy, completeness, and conceptual clarity. The researcher served as the primary scorer and conducted double-check scoring to minimize clerical and judgmental errors. Consistent scoring procedures were applied across all testing sessions. Although inter-rater reliability was not calculated due to single-rater scoring, rubric-based scoring and repeated verification were implemented to enhance scoring reliability (Brookhart, 2018).

Data Collection Procedure

The data collection process was conducted over an eight-week instructional period and followed these steps:

- Students were informed that pre-tests would be administered at the beginning of each lesson to encourage systematic review and preparation.
- Pre-tests for Learning Unit 4 were administered on four occasions (June 29, June 30, July 6, and July 7, 2025).
- The post-unit test for Unit 4 was administered on August 13, 2025.
- Pre-tests for Learning Unit 5 were administered on three occasions (August 14, August 17, August 20, and August 23, 2025).
- The post-unit test for Unit 5 was administered on August 27, 2025.
- All scores were recorded using standardized score recording forms and verified prior to analysis.

Data Analysis

Descriptive statistics (mean and standard deviation) were used to summarize students' pre-test and post-test scores. Paired-samples t-tests were conducted to examine statistically significant differences between pre-test and post-test scores for each learning unit at the .05 significance level. Statistical analyses were performed using standard statistical software.

Results

The results of this study are presented to examine the effects of instructional intervention using pre-tests and post-unit tests on students' learning achievement and practical skill development in Learning Units 4 and 5. Quantitative analyses were conducted using paired-samples t-tests to compare students' pre-test and post-test achievement scores. In addition, descriptive statistics were used to analyze the distribution of students' practical skill levels based on rubric-based performance assessments. Tables 1 and 2 present the comparisons of learning achievement before and after instruction for Learning Units 4 and 5, respectively, while Tables 3 and 4 summarize the distribution of students' practical skill levels in both learning units.

Table 1. Comparison of students' learning achievement before and after instruction learning Unit 4: Factors Affecting Ornamental Plant Growth (n = 22)

Test	N	Maximum Score	Mean	SD	df	t	P (Sig)
Pre-test	22	20	9.95	2.39	21	18.64	.001
Post-test			16.82	1.68			

As shown in Table 1, the mean pre-test score was 9.95 (SD = 2.39), while the mean post-test score increased to 16.82 (SD = 1.68) out of a maximum score of 20. A paired-samples t-test revealed that the post-test scores were significantly

higher than the pre-test scores (t = 18.647, df = 21, p = .001), indicating that the instructional intervention in Learning Unit 4 effectively improved students' learning achievement.

Table 2. Comparison of students' learning achievement before and after instruction learning Unit 5: Horticultural Materials, Tools, and Equipment (n = 22)

Test	N	Maximum Score	Mean	SD	df	t	P (Sig)
Pre-test	22	20	10.64	3.24	21	12.36	.001
Post-test			17.27	2.00			

Table 2, shows that the mean pre-test score was 10.64 (SD = 3.24), whereas the mean post-test score increased to 17.27 (SD = 2.00) out of 20 points. The paired-samples t-test demonstrated a statistically significant difference between pre-test and post-test scores (t = 12.36, df = 21, p = .001), suggesting that the instructional intervention in Learning Unit 5 significantly enhanced students' learning achievement.

Table 3. Students' practical skill levels in learning unit 4: factors affecting ornamental plant growth (n = 22)

Performance Level	Score Range	Frequency (n)	Percentage (%)
Excellent	45 – 50	2	9.09
Very Good	37 – 44	14	63.64
Good	29 – 36	4	18.18
Fair	21 – 28	2	9.09
Needs Improvement	Below 21	0	0.00
Total		**22**	**100.00**

As shown in Table 3, the majority of students demonstrated high levels of practical skills in Learning Unit 4. Specifically, 63.64% of students were classified at the Very Good level and 9.09% achieved the Excellent level. Additionally, 18.18% of students were rated as Good, while 9.09% were at the Fair level. No students were classified as Needs Improvement. These findings indicate that most students developed strong practical competencies in applying procedures related to ornamental plant growth.

Table 4. Students' practical skill levels in learning unit 5: horticultural materials, tools, and equipment (n = 22)

Performance Level	Score Range	Frequency (n)	Percentage (%)
Excellent	45 – 50	1	4.55
Very Good	37 – 44	11	50.00
Good	29 – 36	6	27.27
Fair	21 – 28	2	9.090
Needs Improvement	Below 21	2	9.090
Total		**22**	**100.00**

Table 4, presents the distribution of students' practical skill levels in Learning Unit 5. The results show that 50.00% of students achieved the Very Good level, followed by 27.27% at the Good level and 4.55% at the Excellent level. Additionally, 9.09% of students were classified as Fair, while 9.09% were identified as Needs Improvement. Although the majority of students demonstrated satisfactory to high practical skill levels, a small proportion still required further support to strengthen their practical competencies in the use of horticultural materials and equipment.

Summary

Based on the analyses presented in Tables 1–4, the instructional intervention using pre-tests and post-unit tests significantly enhanced both students' learning achievement and practical skill development. The post-test mean scores for Learning Units 4 and 5 were significantly higher than the pre-test mean scores (t = 18.647, p = .001; t = 12.36, p = .001, respectively), indicating the effectiveness of continuous formative assessment and structured review activities. In addition, rubric-based performance assessment revealed that the majority of students achieved Very Good to Excellent

levels of practical skills. Specifically, 72.73% of students in Learning Unit 4 and 54.55% in Learning Unit 5 demonstrated high performance levels, with only a small proportion of students requiring additional support. Overall, the findings suggest that the instructional approach effectively supported both cognitive achievement and practical competency development.

Based on the paired-samples t-test results, Hypothesis 1 was supported, as students' post-test achievement scores were significantly higher than pre-test scores in both learning units. Furthermore, descriptive analysis of rubric-based performance assessment supported Hypothesis 2, indicating that most students demonstrated high levels of practical skills after instruction.

Discussion

The findings of this study clearly demonstrate that integrating multiple pre-tests and post-unit tests significantly enhanced students' learning achievement in both Learning Unit 4 and Learning Unit 5. The paired-samples t-test results indicated statistically significant improvements in post-test scores compared with pre-test scores (Unit 4: $t = 18.64$, $p = .001$; Unit 5: $t = 12.36$, $p = .001$). These results support the principles of formative assessment and assessment for learning, which emphasize the continuous use of assessment information to guide instructional improvement and promote student learning (Black & Wiliam, 2009; Sortwell et al., 2024).

One plausible explanation for the observed learning gains is the retrieval practice effect, which posits that actively recalling information through frequent testing strengthens memory consolidation and long-term retention more effectively than passive review (Agarwal & Bain, 2019; Kobayashi, 2022). In this study, repeated pre-tests encouraged students to retrieve previously learned content at the beginning of each lesson, reinforcing conceptual understanding and promoting learning continuity. Recent empirical evidence also suggests that retrieval practice not only enhances factual recall but also supports the application of complex concepts and transfer of learning (Corral et al., 2025). This mechanism likely contributed to the substantial improvement in achievement scores observed across both learning units.

In addition, the instructional strategy aligns with the pretesting effect, which indicates that attempting to answer questions before formal instruction—even when responses are initially incorrect—can stimulate curiosity, activate prior knowledge, and increase attention to subsequent learning materials (Little & Bjork, 2016; Mera, 2025). The repeated exposure to pre-tests in this study may have promoted metacognitive awareness and self-regulated learning, enabling students to identify knowledge gaps and focus their study efforts more effectively. This interpretation is consistent with Thai educational research emphasizing the role of formative assessment in supporting learners' reflection and continuous improvement (Metinee Thanongkit, 2022).

Beyond cognitive outcomes, the rubric-based assessment of practical skills revealed that most students achieved Very Good to Excellent performance levels in both learning units, particularly in Learning Unit 4, where no students were classified as needing improvement. These findings suggest that structured formative assessment combined with hands-on learning activities can effectively support the development of procedural competence and task accuracy in vocational education contexts. Rubric-based assessment has been widely recognized as a reliable approach for evaluating performance-based skills, as it clarifies expectations, enhances scoring consistency, and provides meaningful feedback for learners (Brookhart, 2018; Yousef & Ayyoub, 2024).

However, a small proportion of students in Learning Unit 5 remained at the Needs Improvement level, indicating that practical competencies related to the use of horticultural materials and equipment may require additional instructional scaffolding. This outcome may reflect the higher complexity and safety requirements associated with equipment handling, which often demand extended practice, demonstration, and guided supervision. Previous studies in vocational and technical education have emphasized the importance of deliberate practice, step-by-step modeling, and immediate feedback to support skill mastery, particularly for learners with lower initial proficiency (Ericsson & Pool, 2016; Wu et al., 2025). Therefore, supplementary strategies such as micro-practice sessions, safety checklists, peer coaching, and reflective feedback could further enhance practical skill development in future implementations.

Overall, the findings highlight three major implications. First, systematic use of pre-tests and post-unit tests functions effectively as formative assessment and retrieval practice, leading to significant improvements in learning achievement.

Second, rubric-based performance assessment supports the development of practical competencies and provides meaningful evidence of skill progression. Third, differentiated instructional support remains necessary for learners who experience difficulty in complex practical tasks, particularly in equipment-based activities. These implications reinforce the value of integrating assessment-driven instruction within vocational agricultural education to promote both cognitive and practical learning outcomes.

Recommendations

Recommendations for Stakeholders

- Integrate systematic pre-testing and post-unit assessment into routine instruction. Educational institutions and instructors should embed regular pre-tests and post-unit tests as part of daily classroom practice to promote learning continuity, retrieval practice, and formative feedback. This approach can enhance students' preparedness and reinforce conceptual understanding, particularly in vocational and skills-based subjects.
- Use rubric-based performance assessment to strengthen practical skill development. Teachers should adopt well-designed scoring rubrics to evaluate students' practical competencies, as rubrics provide transparent expectations, consistent scoring, and actionable feedback. Continuous rubric-based assessment can support students' self-monitoring and improve the quality of hands-on learning outcomes.
- Provide targeted instructional support for learners with lower practical proficiency. Students who demonstrate fair or low performance levels, especially in complex equipment-based activities, should receive additional scaffolding, such as guided practice, micro-skills training, safety simulations, and individualized feedback to reduce performance gaps and promote equitable skill development.

Recommendations for Future Research

- Examine the long-term retention and transfer effects of repeated pre-testing. Future studies should investigate whether learning gains from multiple pre-tests persist over longer periods and whether students can transfer acquired knowledge and skills to new contexts, real-world tasks, or advanced coursework.
- Explore comparative and mixed-method research designs. Further research may compare different formative assessment strategies (e.g., retrieval practice, peer assessment, digital quizzes, adaptive testing) or integrate qualitative methods such as interviews and classroom observations to better understand learners' cognitive, motivational, and behavioral responses.

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