Jurnal Kependidikan:
Jurnal Hasil Penelitian dan Kajian Kepustakaan di Bidang Pendidikan, Pengajaran dan Pembelajaran
https://e-journal.undikma.ac.id/index.php/jurnalkependidikan/index

Vol. 12, No. 3 : September 2026
E-ISSN: 2442-7667
pp. 1015-1025
Email: jklppm@undikma.ac.id

Microlearning Videos for Green Knowledge Development: Feasibility, Learning Changes, and Cross-Case Patterns in Indonesian Vocational Education

Mustika Nuramalia Handayani*, Najib Tuisina Naenum, Nadia Trianisawati
Study Program of Agroindustrial Technology Education, Faculty of Engineering and Industrial Education, Universitas Pendidikan Indonesia.
*Corresponding Author. Email: mustika@upi.edu

Abstract: This study aims to describe the characteristics and assess the feasibility of videos used in Indonesia's Agribusiness Processing of Agricultural Products (APHP) program, examine changes in students' green knowledge within each case, and identify common and contrasting patterns of green-knowledge development across the two cases. A quantitative descriptive approach with comparative multiple-case secondary analysis was used. Both cases followed the ADDIE model but differed in content, participants, instructional models, implementation periods, and assessment instruments. Product feasibility was assessed through expert validation and student-response questionnaires. Cognitive outcomes were measured using multiple-choice pretests and posttests completed by 31 students in Case 1 and 25 students in Case 2. Six experts reviewed the mapping of the test items to six common green-knowledge domains. In Case 1, expert-validation scores ranged from 83.33% to 86.11%, and student practicality was 79.41%; in Case 2, expert-validation scores ranged from 75.00% to 95.14%, and student practicality was 83.98%. Green-knowledge scores increased from 32.26% to 68.87% in Case 1 and from 69.20% to 82.40% in Case 2, producing moderate normalized gains of 0.54 and 0.43. These results do not show that one instructional combination was superior. Instead, they illustrate two context-specific uses of microlearning: discovery activities for exploring broad environmental issues and project work for connecting sustainability with processing operations. By placing different topic-based tests within one framework, this study provides a practical basis for examining green knowledge across vocational food-processing subjects.

Article History
Received: 13-07-2026
Revised: 16-08-2026
Accepted: 29-08-2026
Published: 20-09-2026

Key Words:
Microlearning Videos; Green Knowledge; Vocational Education; Agribusiness Education; Sustainable Food Processing.

How to Cite: Handayani, M. N., Najib Tuisina Naenum, & Nadia Trianisawati. (2026). Microlearning Videos for Green Knowledge Development: Feasibility, Learning Changes, and Cross-Case Patterns in Indonesian Vocational Education. *Jurnal Kependidikan : Jurnal Hasil Penelitian Dan Kajian Kepustakaan Di Bidang Pendidikan, Pengajaran, Dan Pembelajaran*, *12*(3), 1015-1025. https://doi.org/10.33394/jk.v12i3.22311

https://doi.org/10.33394/jk.v12i3.22311

Introduction

The transition toward environmentally sustainable production has changed the competencies required in the food-processing industry (Gruchmann et al., 2021). Processing activities consume raw materials, water, energy, and packaging while potentially generating emissions, wastewater, solid waste, and food loss. Environmental impacts may also result from contamination, inefficient processing, product deterioration, and the failure to utilize by-products. Because food loss represents wasted natural resources as well as lost products (Sawaya, 2017), workers need to understand how their production decisions affect resource efficiency, product quality, and waste generation. This need places vocational education in a strategic position.

In Indonesia, the *Agribisnis Pengolahan Hasil Pertanian* (APHP) or Agribusiness Processing of Agricultural Products program prepares vocational high school students for employment and entrepreneurship in food processing. Industry practitioners have identified

Vol. 12, No. 3 : September 2026
E-ISSN: 2442-7667
pp. 1015-1025
Email: jklppm@undikma.ac.id

environmental awareness, innovation, adaptability, communication, and waste management as essential competencies for agribusiness vocational graduates (Handayani et al., 2020). Green occupations also require strong cognitive and interpersonal capabilities (Cabral & Dhar, 2021) because workers must adapt to changes in technologies, production standards, and environmental expectations (Tazhbayeva et al., 2023).

Green competence encompasses knowledge, abilities, attitudes, and values (Cabral & Dhar, 2021). However, understanding environmental issues is different from demonstrating practical competence or responsible behavior (Rieckmann, 2018). This study therefore focuses on *green knowledge*, defined as students' understanding of environmental problems, resource efficiency, waste and by-product management, sustainable-production opportunities, and environmentally responsible decisions. In APHP education, this construct covers both environmental concepts, such as climate change, food availability, industrial impacts, and waste management, and operational knowledge related to raw materials, equipment, sanitation, product quality, packaging, and by-product utilization.

Video-based microlearning can make these connections easier to process by dividing complex production systems into short, goal-directed segments and coordinating narration with relevant visuals or demonstrations (Alias & Razak, 2025; Boumalek et al., 2026). This structure can reduce unnecessary cognitive processing and allow learners to focus on one causal relationship or production step at a time, especially when a process is abstract, sequential, or difficult to observe directly (Mayer, 2017). Its value, however, depends on coherent content and purposeful integration with classroom activities rather than on brevity alone (Abidin, 2025).

Previous research has mainly examined microlearning in higher education, teacher education, and general academic settings. It has been associated with improvements in learning performance, motivation, engagement, knowledge retention, and academic achievement (Al-Zahrani, 2024; Fidan, 2023). Questions embedded in instructional videos and subsequently reviewed in class have also been found to improve learning performance (Deng et al., 2024). Evidence remains limited, however, in secondary vocational food-processing education and for green knowledge as a defined cognitive outcome. A further methodological problem is that sustainability-oriented vocational studies commonly use topic-specific tests. This disconnect makes it difficult to compare whether conceptually different technical subjects address a common body of green knowledge. It is therefore unclear how microlearning supports both environmental-conceptual understanding and production-operational understanding within the same vocational field.

Therefore, this study conducted a comparative multiple-case analysis of two independently completed APHP research-and-development studies. The first case addressed climate change, food availability, waste management, and sustainable food production, representing the macro and conceptual side of green knowledge. The second case addressed preparation, sanitation, quality preservation, packaging, and by-product utilization in fruit processing, representing its micro and operational side. The cases were selected because these perspectives are complementary: one explains why environmental change matters to food systems, while the other shows how routine production decisions affect environmental outcomes. They were not selected as equivalent treatments for ranking. The study aimed to: (1) describe the characteristics and feasibility of the videos, (2) analyze changes in students' green knowledge within each case, and (3) identify common and contrasting patterns of green-knowledge development across the two cases.

This study contributes theoretically by defining green knowledge as a distinct and measurable cognitive construct and by linking environmental concepts with sustainable

Vol. 12, No. 3 : September 2026
E-ISSN: 2442-7667
pp. 1015-1025

production decisions in vocational education. Methodologically, it offers a common framework for comparing independently developed interventions without treating their participants or instruments as equivalent. Practically, the findings can inform vocational teachers, curriculum developers, and instructional-media designers in developing microlearning resources that connect sustainability issues with occupational practices in food processing.

Research Method

This study used a quantitative descriptive design with comparative multiple-case secondary analysis. It reanalyzed data from two independently completed research-and-development studies of microlearning videos in vocational food-processing education. Both source studies used the ADDIE model: analysis, design, development, implementation, and evaluation (Trust & Pektas, 2018). The multiple-case approach allowed each study to remain a separate case while supporting a structured comparison. The studies shared a video format and development model but differed in topic, participants, learning model, implementation period, and assessment instrument. Participant data were not pooled, and no inferential comparison was made between groups. The analysis examined product feasibility, within-case knowledge change, and cross-case patterns rather than ranking the interventions.

The data came from two studies conducted in the APHP program at the same vocational high school in West Java, Indonesia. In each study, the students who evaluated the product were different from those who participated in the pretest-posttest implementation. Case 1 involved videos on global issues in food processing, including climate change, food availability, waste management, sustainable agriculture, and sustainable food production. The videos were integrated into discovery learning with Grade X students. Of the students enrolled in the class, 31 completed both the pretest and posttest and were included in the analysis. A separate group of 31 Grade XI students who had previously studied the relevant material evaluated the feasibility and usability of the videos. Case 2 involved four video units on sustainable fruit processing: fruit characteristics and cleaner production, sustainable-processing principles, by-product utilization, and occupational health and safety. The videos were integrated into project-based learning with 25 Grade XI students. Product feasibility was evaluated separately by 21 Grade XII students who had completed the relevant fruit-processing subject.

The analysis used three sources of secondary data: expert-validation sheets, student-response questionnaires, and multiple-choice pretest and posttest results. Expert validation covered content accuracy and alignment, media presentation and accessibility, and language clarity and suitability. Student responses addressed the practicality, clarity, visual presentation, accessibility, and perceived usefulness of the videos. In Case 1, the validation team comprised an APHP teacher, a green-skills and vocational-curriculum expert, an educational-technology expert, and an Indonesian-language teacher. In Case 2, one subject-matter expert, one instructional-media expert, and one language expert conducted the review. Each product was revised in response to the validators' feedback before students evaluated it.

The student-response questionnaires used a four-point Likert scale. Feasibility percentages were calculated by dividing the observed score by the maximum possible score and multiplying the result by 100. Expert-validation scores and student-practicality responses were reported as separate evidence because they came from different evaluators and measured different aspects of product quality.

Vol. 12, No. 3 : September 2026
E-ISSN: 2442-7667
pp. 1015-1025
Email: jklppm@undikma.ac.id

The resulting percentages were interpreted using the categories adopted in the respective source studies. Because the validators, questionnaire indicators, and student groups differed, the feasibility results were reported separately and were not averaged across cases.

Students' cognitive outcomes were measured using multiple-choice tests. Case 1 used 20 items covering environmental problems and solutions, food availability, waste management, and sustainable food-production opportunities. The instrument was reviewed for content relevance, item construction, language, and image clarity. After revision, it received a feasibility score of 82.64%.

Case 2 used 10 items addressing the environmental impacts of fruit processing, raw-material and equipment preparation, fruit damage, sanitation and hygiene, product quality, packaging, by-product management, and the utilization of dragon-fruit peel. The instrument was reviewed for its content, construction, and language and received a feasibility score of 75.00%. Affective and psychomotor measures from the original study were excluded because the present analysis focused on cognitive outcomes. Because the two tests were developed for different topics, their items were mapped onto a common green-knowledge framework before the comparative analysis. The framework consisted of six domains: environmental problems (GK1), environmental solutions (GK2), resource efficiency and food security (GK3), waste and by-product management (GK4), green-growth opportunities (GK5), and sustainable production operations (GK6).

The final domain covered operational decisions that could help prevent contamination, product loss, inefficient resource use, or avoidable waste. It included knowledge related to raw-material quality, equipment readiness, sanitation, product-quality preservation, and packaging. These topics were included only when their relationship with sustainable production could be clearly established.

The mapping process involved four steps. First, each item was examined in terms of its content and intended cognitive outcome. Second, it was provisionally assigned to one of the six green-knowledge domains. Third, the proposed classifications and construct boundaries were reviewed by six validators with expertise in green skills, vocational curriculum development, and APHP teaching. Finally, the initial classifications were refined in response to the validators' comments and confirmed for use in the analysis. Following this review process, all 30 items were considered relevant to the green-knowledge framework and were retained. The available validation records did not include item-level consensus percentages or inter-rater agreement coefficients. Therefore, the validation results are reported as descriptive expert judgment rather than as statistical evidence of inter-rater reliability.

The videos were developed through the five stages of ADDIE. During the analysis stage, the researchers examined curriculum requirements, learning objectives, student needs, school conditions, and limitations in the available learning resources. The design stage involved preparing the objectives, content structure, flowcharts, storyboards, video sequences, and research instruments. During development, the videos were produced, reviewed by experts, and revised. Students who had previously studied the relevant material then evaluated the products. Learning-outcome data were collected through pretests and posttests during classroom implementation. Case 1 was conducted face-to-face in one meeting. Students used the videos within discovery-learning activities focused on global issues in food processing. Case 2 was conducted over two meetings using project-based learning. Its activities included fruit processing and the utilization of dragon-fruit peel as a production by-product. For the present study, expert-validation results, student responses, pretest and posttest scores, and item-level correct-response counts were extracted from the

Vol. 12, No. 3 : September 2026
E-ISSN: 2442-7667
pp. 1015-1025
Email: jklppm@undikma.ac.id

two research reports. Only anonymized aggregate data were used. Students' names and other personal identifiers were not included in the analytical dataset.

The data were analyzed descriptively at the group, domain, and item levels to summarize the observed response patterns without making inferential or causal claims (Loeb et al., 2017). First, the overall percentage of correct responses was calculated separately for each pretest and posttest:

$$\text{Score (\%)} = \frac{\text{total correct responses}}{n \times m} \times 100$$

where n represents the number of students and m the number of test items. The maximum possible response totals were $31 \times 20 = 620$ for Case 1 and $25 \times 10 = 250$ for Case 2. Second, correct responses were grouped according to the six domains to examine changes in different areas of knowledge. Third, item-level totals were used to identify topics showing substantial, limited, or no improvement. Individual response transitions could not be examined because student-level item data were unavailable. A group-level normalized gain was calculated for both cases using the same procedure:

$$g = \frac{\text{posttest percentage} - \text{pretest percentage}}{100 - \text{pretest percentage}}$$

Following Nissen et al. (2018), normalized gains were categorized as low ($g < 0.30$), moderate ($0.30 \leq g < 0.70$), and high ($g \geq 0.70$). The analysis used the recalculated group-level gains rather than the mean individual gains reported in the source studies. This ensured that the same calculation was applied to both cases. The cross-case analysis compared product characteristics, feasibility results, initial and final scores, normalized gains, and domain- and item-level patterns. The purpose was to identify convergence and contrast, not to rank the effectiveness of the products.

Results and Discussion

Results

Product Characteristics and Feasibility

The two products followed the same ADDIE development process but were designed for different classroom purposes. Case 1 introduced global warming, climate change, food availability, waste management, sustainable agriculture, and sustainable food production. Students accessed the videos through a website linked to YouTube and used them as part of discovery-learning activities. Case 2 contained four units on fruit characteristics and cleaner production, sustainable fruit processing, by-product utilization, and occupational health and safety. These videos supported a project in which students processed fruit and used dragon-fruit peel as a by-product. Table 1 presents the feasibility results.

Table 1. Product-feasibility results

Evaluation component	Case 1 (%)	Category	Case 2 (%)	Category
Material validation	86.11	Very feasible	75.00	Feasible
Media validation	83.33	Very feasible	84.95	Very feasible
Language validation	83.33	Very feasible	95.14	Very feasible
Student response	79.41	Feasible	83.98	Very feasible

As shown in Table 1, every evaluation component met the feasibility criterion. The three expert scores in Case 1 were close to one another, while students gave a somewhat lower practicality rating. Case 2 showed a wider spread: language received the highest score and material validation the lowest. Expert judgments and student responses are presented separately because they represent different sources of evidence.

Overall Changes in Green Knowledge

Jurnal Kependidikan:
Jurnal Hasil Penelitian dan Kajian Kepustakaan di Bidang Pendidikan, Pengajaran dan Pembelajaran
https://e-journal.undikma.ac.id/index.php/jurnalkependidikan/index
Vol. 12, No. 3 : September 2026
E-ISSN: 2442-7667
pp. 1015-1025
Email: jklppm@undikma.ac.id

Knowledge scores increased in both cases (Table 2). Case 1 moved from 200 to 427 correct responses out of 620, an increase from 32.26% to 68.87%. Its group-level N-gain was 0.54. Case 2 moved from 173 to 206 correct responses out of 250; the percentage rose from 69.20% to 82.40%, with an N-gain of 0.43. Both gains were in the moderate category.

Table 2. Overall changes in green knowledge

Case	Students	Items	Correct responses: pretest	Correct responses: posttest	Pre test (%)	Post test (%)	Change (percentage points)	N-gain	Category
Case 1	31	20	200/620	427/620	32.26	68.87	+36.61	0.54	Moderate
Case 2	25	10	173/250	206/250	69.20	82.40	+13.20	0.43	Moderate

The group-level gains are slightly different from the mean individual gains reported in the source studies (0.51 for Case 1 and 0.39 for Case 2). For the present comparison, the group-level values were retained because the same calculation could be applied to both datasets.

Domain-Level Results in Case 1

The 20 Case 1 items represented five green-knowledge domains. Table 3 presents the pretest and posttest results for each domain.

Table 3. Green-knowledge results by domain in Case 1

Domain	Items	Pretest (%)	Posttest (%)	Change (percentage points)
GK1: Environmental problems	1–5	43.87	81.94	+38.07
GK2: Environmental solutions	6–7	40.32	75.81	+35.49
GK3: Resource efficiency and food security	8–11	25.81	60.48	+34.67
GK4: Waste and by-product management	12–14	32.26	66.67	+34.41
GK5: Green-growth opportunities	15–20	24.19	62.37	+38.18

Scores increased across all five domains. Environmental problems reached the highest posttest score at 81.94%, followed by environmental solutions at 75.81%. Green-growth opportunities showed the largest change, increasing by 38.18 percentage points. Resource efficiency and food security had the lowest posttest score at 60.48%. At the item level, the largest increase occurred in Item 19, which addressed innovative sustainable food-processing practices. Correct responses increased from 6 to 26 students. Item 5, concerning the relationship between climate change and food processing, increased from 8 to 27 correct responses. Item 9, which addressed food availability at different geographical levels, increased from 3 to 21. The smallest change occurred in Item 3, concerning the causes and effects of global warming, which increased from 23 to 26 correct responses. Its pretest score was already among the highest in the case.

Domain-Level Results in Case 2

The 10 items in Case 2 represented three domains. The results are shown in Table 4.

Table 4. Green-knowledge results by domain in Case 2

Domain	Items	Pretest (%)	Posttest (%)	Change (percentage points)
GK1: Environmental problems	1	40.00	60.00	+20.00
GK4: Waste and by-product management	2, 8, and 10	76.00	88.00	+12.00
GK6: Sustainable production operations	3–7 and 9	70.67	83.33	+12.66

Vol. 12, No. 3 : September 2026
E-ISSN: 2442-7667
pp. 1015-1025
Email: jklppm@undikma.ac.id

Environmental problems increased by 20.00 percentage points. Waste and by-product management recorded the highest posttest score at 88.00%. Sustainable production operations increased from 70.67% to 83.33%. Table 5 presents the item-level changes.

Table 5. Item-level changes in Case 2

Item	Knowledge focus	Pretest correct	Posttest correct	Change
1	Impacts of fruit-processing activities	10	15	+5
2	Handling and utilization of by-products	17	18	+1
3	Equipment inspection and cleaning	22	23	+1
4	Selection of fruit according to maturity	20	20	0
5	Identification of physiological fruit damage	8	20	+12
6	Occupational health, sanitation, and hygiene	19	22	+3
7	Organoleptic-quality evaluation	12	15	+3
8	Jelly production using dragon-fruit peel	20	25	+5
9	Packaging to prevent contamination	25	25	0
10	Use of dragon-fruit peel as a natural colorant	20	23	+3

Item 5 showed the largest increase, rising from 8 to 20 correct responses. Items 4 and 9 did not change. Item 9 was answered correctly by all 25 students in both tests. Items 2 and 3 each increased by one correct response.

Cross-Case Results

Although both cases produced moderate group-level N-gains, their score patterns were not alike. Case 1 started at a much lower level, improved across five green-knowledge domains, and recorded the larger percentage-point increase. Case 2 started higher, changed across three domains, and finished with the higher posttest score.

These patterns arose under different instructional and assessment conditions. Case 1 involved Grade X students, one discovery-learning meeting, and a 20-item test focused mainly on environmental concepts. Case 2 involved Grade XI students, two project-based meetings, and a 10-item test focused mainly on production operations. Given these differences in participants, grade level, content, instruments, learning model, and duration, the cases were not pooled, and no direct test of between-case differences was performed.

Discussion

Interpretation of the Findings

In both cases, students knew more at the end of the learning activities than at the beginning, but the knowledge that developed was different. Case 1 began with low scores across many topics. Improvement appeared in students' understanding of environmental problems, possible responses, food security, waste management, and green-growth opportunities. The greatest change concerned sustainable-production opportunities, which had also been one of the least familiar topics at pretest. By the end of the lesson, students were not only better able to recognize environmental problems; more of them could also identify innovation and economic opportunity within sustainable food processing.

One particularly useful shift in Case 1 was the stronger connection students made between climate change and food processing (Huambachano et al., 2022). For vocational students, climate change may seem distant from the routines of a processing workshop. Relating it to production helped bring the issue closer to the occupations for which they were

Jurnal Kependidikan:
Jurnal Hasil Penelitian dan Kajian Kepustakaan di Bidang Pendidikan, Pengajaran dan Pembelajaran
https://e-journal.undikma.ac.id/index.php/jurnalkependidikan/index
Vol. 12, No. 3 : September 2026
E-ISSN: 2442-7667
pp. 1015-1025
Email: jklppm@undikma.ac.id

preparing, rather than leaving it as a separate and largely abstract topic (Serhan & Yannou-Lebris, 2021).

Some areas nevertheless remained difficult. Posttest scores for resource efficiency and food security, waste management, and green-growth opportunities were still only about 60%–67%. Food systems involve ecological, economic, energy, health, and social relationships, so these topics are unlikely to be mastered through a single explanation (Myers et al., 2017). Climate change adds further links among production, resource availability, supply chains, and food security (Firdaus et al., 2019). The one-meeting format used in Case 1 may therefore have been too brief for students to work through all of these relationships. Further examples and discussion across several meetings would be appropriate. This interpretation is consistent with evidence that learning spaced over time is generally retained better than learning concentrated in one session (Walsh et al., 2023). Short video units can support such revisiting, provided that they remain connected to the wider lesson (Mostrady et al., 2025).

Case 2 told a different story. Students already knew a good deal about by-product management and routine sustainable-production practices, yet many initially had difficulty identifying physiological fruit damage. After the intervention, this item showed the largest change. The topic matters environmentally as well as technically: damaged fruit can reduce usable yield, shorten shelf life, lower product quality, and increase food loss. Physiological, mechanical, and pathological damage are well-established sources of postharvest loss in perishable fruit (Liu et al., 2025; Yahia & Carrillo-Lopez, 2018). When students learn to recognize these conditions, decisions about selection, handling, storage, and processing can be made with less avoidable loss. In this sense, an operational topic becomes green knowledge when its environmental consequence is made clear.

Case 2's smaller gain should also be read in light of its high starting score. Several items offered little room for improvement; for packaging, every student was correct at both test points. Two contextual factors may have contributed to this baseline. The Case 2 students were in Grade XI and had received more vocational instruction than the Grade X students in Case 1. They may also have been more familiar with raw-material selection, sanitation, packaging, and by-product use than with broad issues such as climate change, food security, and green growth. The aggregate data cannot separate these explanations. Thus, the baseline is best treated as part of the context, not as proof that the Case 2 material was easier or that the larger Case 1 gain reflected a better product.

The findings are consistent with studies showing that microlearning can support cognitive outcomes when it is built into a structured learning process. Fidan (2023) reported that a microlearning-supported flipped classroom improved preservice teachers' learning performance, motivation, and engagement. Al-Zahrani (2024) similarly found positive outcomes for accessibility, knowledge retention, learning experience, and academic achievement. The present findings also support the argument that videos are more useful when learners do something meaningful with their content. Deng et al. (2024) found that embedding questions in videos and reviewing them in class improved learning performance. In the present cases, the videos were similarly connected to wider learning activities. Students in Case 1 explored environmental problems through discovery learning, while those in Case 2 used the videos to support production-oriented projects.

The results concerning waste and by-product management are also relevant to the needs of the food-processing industry. Handayani et al. (2020) found that industry practitioners regarded waste management as an important green competency for agribusiness vocational graduates. The present study adds an educational perspective to this finding by

Jurnal Kependidikan:
Jurnal Hasil Penelitian dan Kajian Kepustakaan di Bidang Pendidikan, Pengajaran dan Pembelajaran
https://e-journal.undikma.ac.id/index.php/jurnalkependidikan/index
Vol. 12, No. 3 : September 2026
E-ISSN: 2442-7667
pp. 1015-1025
Email: jklppm@undikma.ac.id

showing how such knowledge can be incorporated into APHP (Agribusiness Processing of Agricultural Products) lessons through both environmental topics and processing activities.

The Case 2 result offers a concrete way to view microlearning through Mayer's multimedia-learning principles. Physiological fruit damage combines several visual signs and possible causes, which can be difficult to process when presented together. In the video, these features were broken into focused segments and paired with relevant explanations and images. This may have allowed students to attend to one sign at a time before relating the signs to the broader condition. Twelve more students answered Item 5 correctly at posttest, the largest item-level change in the case. The pattern fits the coherence, signaling, and segmentation principles described by Mayer (2017), although the study did not measure cognitive load or compare alternative video designs. The proposed mechanism should therefore be read as a plausible interpretation, not a tested causal explanation.

Viewed together, the cases also broaden the meaning of green knowledge in food-processing education. Climate change, food security, and industrial waste clearly belong within this construct. So do routine decisions about raw materials, equipment, sanitation, product quality, packaging, and by-products when those decisions influence resource use or waste generation. There is an important boundary, however. Technical content is not green simply because it belongs to a production subject. Its inclusion is warranted only when the link to an environmental outcome, such as resource efficiency, prevention of food loss, or reduction of pollution, is stated and assessed explicitly. For APHP teaching, sustainability can be addressed within subjects that students already study rather than being reserved for a separate environmental lesson. Raw-material selection can be discussed in relation to usable yield and food loss; sanitation in relation to rejected products; packaging in relation to protection and material use; and by-product processing in relation to waste reduction and added value.

The videos are most useful when they lead into another activity. In a discovery lesson, a short segment can pose a problem, provide evidence, or give students something to question. During project work, it can model a procedure, help students plan production, or provide a basis for judging the environmental consequences of their choices. What follows the video is therefore as important as the video itself. A guiding question, worksheet, group discussion, demonstration, or short reflection can move students from watching to making sense of a production decision. This is also where teachers can connect the screen-based explanation with conditions students are likely to meet in a school workshop or workplace. The item results provide a practical check on assessment quality. Questions answered correctly by nearly everyone at pretest, such as the packaging item in Case 2, reveal little about learning growth. Scenario-based questions would be more informative because they ask students to compare options, anticipate consequences, or justify a sustainable choice. Conversely, topics that remained weak after instruction should receive more time, different examples, or another opportunity for students to revisit them.

Conclusion

This study concludes that both microlearning-video products were feasible for use in APHP (Agribusiness Processing of Agricultural Products) education and were followed by moderate gains in students' green knowledge. The results show that microlearning-videos can support environmental-conceptual and production-operational knowledge when integrated into discovery learning or project-based learning. However, the differences between the cases do not establish that one product was more effective because the participants, baseline scores, content, instruments, instructional models, and implementation periods were not equivalent.

These conclusions are limited to cognitive outcomes and do not confirm changes in practical skills, attitudes, or sustainable behavior.

Recommendation

APHP teachers should begin with a brief entry-level assessment before choosing or producing microlearning videos. Knowing what students already understand and how familiar they are with the topic will help teachers set an appropriate level of difficulty and choose suitable follow-up work. Videos on broad environmental issues can lead into guiding questions, discussion, and discovery activities; videos on production operations can be followed by demonstrations, projects, or practical tasks that make resource use and waste visible. School principals can support this work by providing reliable digital facilities, time for teachers to plan together, and relevant professional development. At the policy level, education offices and the Ministry of Education can strengthen green knowledge in APHP curriculum guidance and support shared, validated learning resources and assessment standards. Further studies should use a common validated instrument, retain individual-level data, include comparison groups, and add delayed and performance-based assessments while taking initial knowledge and topic familiarity into account.

References

Al-Zahrani, A. M. (2024). Enhancing postgraduate students' learning outcomes through Flipped Mobile-Based Microlearning. *Research in Learning Technology*, *32*.

Alias, N. F., & Razak, R. A. (2025). Revolutionizing learning in the digital age: A systematic literature review of microlearning strategies. *Interactive Learning Environments*, *33*(1), 1-21.

Boumalek, K., Bakki, A., El Mezouary, A., Hmedna, B., & Eddahibi, M. (2026). Micro-learning design and micro-course structuring: a systematic literature review. *Interactive Learning Environments*, *34*(4), 2411-2437.

Cabral, C., & Dhar, R. L. (2021). Green competencies: insights and recommendations from a systematic literature review. *Benchmarking: An International Journal*, *28*(1), 66-105.

Deng, R., Feng, S., & Shen, S. (2024). Improving the effectiveness of video-based flipped classrooms with question-embedding. *Education and Information Technologies*, *29*(10), 12677-12702.

Fidan, M. (2023). The effects of microlearning-supported flipped classroom on pre-service teachers' learning performance, motivation and engagement. *Education and Information Technologies*, *28*(10), 12687-12714.

Firdaus, R. R., Senevi Gunaratne, M., Rahmat, S. R., & Kamsi, N. S. (2019). Does climate change only affect food availability? What else matters?. *Cogent Food & Agriculture*, *5*(1), 1707607.

Gruchmann, T., Timmer, V., Gold, S., & Gessner, C. (2021). Dynamic capabilities for sustainable change in the food processing industry: A multilevel perspective. *Journal of Cleaner Production*, *311*, 127534.

Handayani, M. N., Ali, M., & Mukhidin, D. W. (2020). Industry perceptions on the need of green skills in agribusiness vocational graduates. *Journal of Technical Education and Training*, *12*(2), 24-33.

Huambachano, M., Arulingam, I., Bowness, E., Korzenszky, A., Mungai, C., Termine, P., & Wittman, H. (2022). Knowledge networks to support youth engagement in sustainable food systems. *Frontiers in Sustainable Food Systems*, *6*, 867344.

Vol. 12, No. 3 : September 2026
E-ISSN: 2442-7667
pp. 1015-1025
Email: jklppm@undikma.ac.id

Loeb, S., Dynarski, S., McFarland, D., Morris, P., Reardon, S., & Reber, S. (2017). Descriptive Analysis in Education: A Guide for Researchers. NCEE 2017-4023. *National Center for Education Evaluation and Regional Assistance*.

Liu, F., Hai, M., Mei, B., Yi, L., & Xie, S. (2025). How does mechanical damage affect the preservability of postharvest fruits and vegetables?. *LWT*, 118781.

Mayer, R. E. (2017). Using multimedia for e-learning. *Journal of Computer Assisted Learning*, *33*(5), 403-423.

Mostrady, A., Sanchez-Lopez, E., & Gonzalez-Sanchez, A. F. (2025). Microlearning and its effectiveness in modern education: A mini review. *Acta Pedagogia Asiana*, *4*(1), 33-42.

Myers, S. S., Smith, M. R., Guth, S., Golden, C. D., Vaitla, B., Mueller, N. D., ... & Huybers, P. (2017). Climate change and global food systems: potential impacts on food security and undernutrition. *Annual review of public health*, *38*, 259-277.

Nissen, J. M., Talbot, R. M., Nasim Thompson, A., & Van Dusen, B. (2018). Comparison of normalized gain and Cohen's d for analyzing gains on concept inventories. *Physical Review Physics Education Research*, *14*(1), 010115.

Rieckmann, M. (2018). Learning to transform the world: Key competencies in Education for Sustainable Development. *Issues and trends in education for sustainable development*, *39*(1), 39-59.

Sawaya, W. N. (2017). Impact of food losses and waste on food security. In *Water, energy & food sustainability in the Middle East: The sustainability triangle* (pp. 361-388). Cham: Springer International Publishing.

Serhan, H., & Yannou-Lebris, G. (2021). The engineering of food with sustainable development goals: policies, curriculums, business models, and practices. *International Journal of Sustainable Engineering*, *14*(1), 12-25.

Tazhbayeva, A., Aimagambetov, Y., Tazhbayev, N., & Grela, M. F. (2023). Impact of Environmental Standards on Employment. *Journal of Environmental Management & Tourism*, *14*(3), 767-777.

Trust, T., & Pektas, E. (2018). Using the ADDIE model and universal design for learning principles to develop an open online course for teacher professional development. *Journal of Digital Learning in Teacher Education*, *34*(4), 219-233.

Walsh, M. M., Krusmark, M. A., Jastrembski, T., Hansen, D. A., Honn, K. A., & Gunzelmann, G. (2023). Enhancing learning and retention through the distribution of practice repetitions across multiple sessions. *Memory & Cognition*, *51*(2), 455-472.

Yahia, E. M., & Carrillo-Lopez, A. (Eds.). (2018). *Postharvest physiology and biochemistry of fruits and vegetables*. Woodhead Publishing.