Needs analysis of canva-based interactive web learning media with deep learning integration for food chemistry courses

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Abstract
This study aimed to investigate to investigate learning needs and establish specifications for an interactive web-based learning medium using Canva and deep learning technology for a university Food Chemistry course, with a focus on fish preservation. A qualitative needs analysis was conducted through semi-structured interviews with a Food Chemistry lecturer selected through purposive sampling, along with document analysis of the Semester Learning Plan (RPS) and course instructional materials. Two key findings were identified. First, existing learning resources, including textbooks, e-books, and PowerPoint presentations, provided limited support for the development of Higher-Order Thinking Skills (HOTS). Document analysis further revealed that fish preservation was not explicitly addressed in the RPS and that available learning media lacked interactive and visual elements. Second, interview findings indicated a strong need for contextual and engaging learning materials that connect course content with real-world applications. Based on these findings, specifications were formulated for an interactive web-based learning platform using Canva and incorporating a proposed CNN-based fish freshness detection feature that utilizes fish eye characteristics as visual indicators of freshness. The findings suggest that such a platform has the potential to enhance student engagement and support the development of HOTS through authentic learning experiences. This study provides an empirically informed framework for integrating contextual learning, interactive web media, and artificial intelligence in Food Chemistry education.

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1. Introduction

The role of higher education highlights the significance of graduates with not only academic excellence but also digital literacy and professional competencies in line with global expectations in the context of the Fourth Industrial Revolution (Shahab & Barak, 2026). Higher education institutions must therefore change their pedagogical frameworks in order to transition from traditional teacher-centered models to student-centered learning environments (Awacorach et al., 2021). In the sphere of science, where the abstract and complicated nature of the subject matter necessitates significant adaptation, such a transition feels more and more necessary (George & Siranchuk, 2025). In order to improve conceptual mastery and develop higher-order thinking abilities, especially critical thinking, creative teaching methods are therefore crucial (Mirza & Jabeen, 2024). These abilities are essential for helping students analyze information, assess arguments, and come to logical conclusions about complicated global challenges (Brahim, 2024).

The reality of implementation in the field still emphasizes the predominance of lecture-based methods that tend to repress students' active engagement, despite the broad understanding of the necessity of promoting critical thinking (Padilla Petry et al., 2025). As a result, the learning process frequently lacks substance, with students memorizing concepts without being able to apply them to empirical circumstances (Kristidhika et al., 2020). As a targeted solution, the Contextual Teaching and Learning (CTL) approach appears as a strategic option (Basuki et al., 2025). This approach is ideal for use in Food Chemistry courses, particularly on the topic of fish preservation, which is strongly tied to food safety concerns and socioeconomic elements in Indonesia. This issue involves complex chemical processes such as oxidation reactions, microbiological activity, and protein denaturation, which are difficult to understand when only reading textual and diagrammatic sources (Tahiluddin et al., 2022).

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Canva and other online graphic design platforms help create interactive visual teaching materials that enable contextual learning (Astaño, 2025). These platforms' ease of use and versatility allow instructors to generate customizable learning resources without requiring much technological expertise (Hidayati et al., 2023). Meanwhile, integrating Deep learning (DL) technology as a form of artificial intelligence paves the way for adaptive and personalized learning systems (Wang et al., 2024). The combination of these two technologies is therefore projected to create a more engaging and effective learning environment.

This research is based on the principles of Contextual Teaching and Learning (CTL) in terms of pedagogy that emphasizes the importance of linking academic concepts to real-world situations so that the students perceive the material they are learning to be meaningful. Specifically, CTL serves as the pedagogical foundation that connects Canva's interactive visual features to authentic learning contexts, while deep learning technology provides the AI-assisted problem-solving component together forming an integrated framework designed to potentially scaffold HOTS development in Food Chemistry education.

While previous studies have explored e-module development for critical thinking and the use of interactive simulations in science education (Alim et al., 2025; Haryadi et al., 2026; Sajidan et al., 2025) and Canva as a standalone design tool (Gustavo & Rodriguez, 2024; Kaysi, 2025; Kefalis et al., 2025), these studies have examined visual design tools and AI-assisted learning as separate domains, without exploring their integration within a single learning medium particularly in the context of Food Chemistry education in Indonesian higher education. Furthermore, no study has specifically addressed the instructional requirements and media specifications necessary for integrating Canva-based interactive web media with deep learning technology in the context of fish preservation. This gap underscores the need for a systematic needs analysis prior to media development, which this study seeks to address through lecturer perspectives and document analysis.

This study is unique in that it combines three elements that have never been combined in Food Chemistry education: (1) an interactive web-based platform with Canva as the primary delivery platform, (2) CTL principles as the pedagogical foundation, and (3) a CNN-based fish freshness detection feature designed as an AI-supported authentic learning tool. Unlike previous studies, which have focused on the utility of platforms or the implementation of AI separately, this study addresses instructional design and technological specifications within the specific domain of Food Chemistry education, providing a replicable framework for the development of technology-integrated media in higher education.

This study therefore aims to: (1) identify the characteristics and suitability of current learning media for Food Chemistry instruction, and (2) formulate instructional and technological specifications for a Canva-based interactive web learning platform integrated with deep learning technology to systematically support the development of Higher-Order Thinking Skills (HOTS) including analysis, evaluation, and problem-solving through contextual and AI-assisted learning experiences. The findings of this study are expected to provide an empirical foundation for learning media innovation, as well as enrich the broader discussion on educational technology applications in higher education settings.

2. Method

This study employed a qualitative needs analysis approach to identify instructional needs and formulate specifications for Canva-based interactive web learning media integrated with deep learning technology. Data were collected through two qualitative sources, namely semi-structured interviews and document analysis. The use of multiple data sources enabled triangulation and strengthened the credibility of the findings. The participant in this study was one Food Chemistry lecturer from the Department of Science Education, Universitas Bengkulu. The participant was selected through purposive sampling and served as a key informant due to direct involvement in teaching the course, familiarity with the Semester Learning Plan (RPS) and experience with instructional materials used in Food Chemistry learning.

The study was conducted during the odd semester of the academic year. The primary instrument was a semi-structured interview guide designed to explore two main areas: (1) the Scharacteristics and suitability of existing learning media used in Food Chemistry instruction, and (2) the specifications required for future Canva-based interactive web learning media integrated with deep learning technology. The interview protocol consisted of six indicators: (1) characteristics of existing learning media, (2) strengths and limitations of current media, (3) alignment between learning media and course learning outcomes, (4) requirements for supporting Higher-Order Thinking Skills (HOTS), (5) desired features of future learning media, and (6) expectations regarding the integration of deep learning technology in Food Chemistry instruction. The interview guide was pilot-tested with lecturers who had similar academic backgrounds, and minor revisions were made to improve clarity.

In addition to interviews, document analysis was conducted to evaluate the adequacy of instructional materials used in the Food Chemistry course. The analyzed documents consisted of: (1) the Semester Learning Plan (RPS) and (2) the textbook used by the course lecturer. Document analysis was employed to provide

objective evidence regarding the alignment between learning objectives, instructional materials, and the development of Higher-Order Thinking Skills (HOTS), thereby complementing the interview findings.

The document analysis followed an evaluation framework consisting of five dimensions. The evaluation of the RPS focused on: (a) alignment between learning outcomes and HOTS development, (b) inclusion of technology-based interactive learning media, and (c) consistency between learning outcomes and recommended instructional media. The textbook evaluation examined: (a) the completeness and depth of content, (b) visual quality and use of illustrations, (c) the presence of interactive elements and opportunities for student engagement, and (d) the suitability of the materials for supporting HOTS development. Each document was analyzed independently and subsequently compared to identify areas of alignment and discrepancy. This technique was chosen as a supplement because it gives unbiased empirical data about the actual conditions of the teaching materials and planning, thereby enriching the subjective information from the interviews (Özkan, 2023).

3. Results and Discussion

3.1. Results

A thematic analysis of interview data with Food Chemistry instructors, supplemented by the results of a systematic document analysis, revealed two key themes relevant to the requirements and specifications of interactive online learning materials built with Canva and deep learning technology.

3.1.1. Characteristics and Applicability of Current Instructional Media in Food Chemistry Education

The findings of the semi-structured interviews revealed that the present learning resources for the Food Chemistry course are still insufficient and do not fully meet the needs outlined in the Semester Learning Plan. According to the instructors, the media used are e-books, PowerPoint presentations, and traditional textbooks, which are not yet ideal in terms of supporting learning outcomes, particularly the development of students' critical, analytical, and inventive thinking (CPL-4). One instructor said, "The media we currently use are still very limited; there are no interactive media that truly support students in learning independently and contextually as expected in the RPS" (L1). This comment implies that lecturers are aware of the stark contrast between formal curricular demands in the RPS and the reality of available learning resources (Railean, 2025).

A review of the Food Chemistry course syllabus reveals neutral empirical evidence that supports the instructor's claims and exposes two major concerns. First, the RPS expressly defines learning goals that prioritize higher-order thinking skills, particularly CPL-4, which requires students to "apply logical, critical, systematic, and innovative thinking in the context of the development or application of science and technology." However, there was a significant structural mismatch between these curricular aims and the descriptions of learning themes in the RPS. Food preservation, one of the most important and contextually relevant issues in food chemistry, is not even mentioned as a separate course unit. The most closely related topic is food additives, which covers preservatives as one form of addition but does not include fish preservation as a clear and thorough case study in applied chemistry. Such a curricular gap marks a missed chance to connect chemical theory with highly relevant real-world practice, while also acting as the major foundation for the media development envisioned in this research.

Second, the Course Syllabus's recommendations for learning media are limited to e-books, PowerPoint presentations, instructional videos, and Zoom Cloud Meetings, with no mention of web-based interactive media or adaptive digital tools. The RPS's principal references are likewise dominated by traditional textbooks with old publication dates, which cannot provide the dynamic visualizations, interactive aspects, or adaptive feedback systems required to realize CPL-4 (Wang, 2025). This insight highlights the structural mismatch between the RPS's aspirational learning outcomes and the quality of the media suggested for achieving them. Third, the evaluation techniques stated in the Course Syllabus continue to rely on traditional approaches such as essay and oral exams. Although Project-Based Learning (PBL) has been implemented, there are no realistic, standardized assessment rubrics for Higher-Order Thinking Skills (HOTS). This condition is consistent with input from faculty interviews, showing that present evaluation procedures are not currently effective in completely and fairly measuring students' analytical and evaluative competencies.

An assessment of currently used textbooks supports these conclusions. These textbooks convey food chemistry topics, including discussions of preservatives, mostly through dense text that lacks diagrams, process flow charts, and visual demonstrations of chemical mechanisms. Interactive elements, formative assessments, and adaptive features are also missing, rendering them ineffective for encouraging active student engagement or accommodating different learning paces (Gligorea et al., 2023). The synthesis of evidence from the analysis of the RPS and this textbook provides a solid empirical foundation from several sources, emphasizing the

importance of providing novel, interactive, and contextual learning tools for the Food Chemistry course (Ali et al., 2023).

3.1.2. The Suitability of Canva-Based Interactive Web Media Integrated with Deep learning

The instructors felt that interactive web-based learning materials created with the Canva platform, which incorporates Deep learning technology, are ideal for the Food Chemistry course, particularly the subtopic of fish preservation under the additive compounds module. These resources have the ability to bridge the gap between theoretical material presented in standard textbooks and students' demand for contextual learning experiences with practical applications. As an example, the teachers pointed out that the Deep learning-based fish freshness detection tool allows students to input photos of fish samples and receive forecasts of their freshness state via artificial intelligence analysis. This approach is a useful laboratory activity that connects scientific principles like protein denaturation, lipid oxidation, and microbial degradation to real-world food safety assessments. As a result, students are actively encouraged to utilize their understanding of chemical processes in determining the quality of food products relevant to their daily lives, rather than simply remembering them.

Instructors also stated that Canva-based web content's visual and interactive aspects, such as animated diagrams, embedded movies, and interactive quizzes, are well-suited to the learning styles of today's students. Students in the digital age adapt well to virtual environments and prefer engaging visual content over static text (Regondola & Astorga, 2025). Nonetheless, instructors identified a key challenge: students' limited access to reliable internet connections and different levels of digital literacy, which could disrupt the consistent usage of media in various learning scenarios. Despite these challenges, the instructors unanimously agreed that the proposed media are a vital innovation. Its deployment is expected to fill the gaps found in both the present semester learning plans (RPS) and textbooks.

Based on the findings of interviews and document evaluations, the instructors created a complete set of specifications for developing the necessary interactive web-based learning resources. These resources must be based on a contextual learning strategy, presenting knowledge not as a collection of separate chemical facts, but as comprehensive answers to real-world problems that students can recognize and understand. The instructors underlined the importance of introducing the media through a contextual problem scenario that demonstrates the dynamics of the Indonesian fish distribution network, with a focus on how the length of the supply chain frequently increases fish rotting. This phenomena is intimately related to the biochemical pathways and microbial activity discussed in the Chemistry course (Zuleni et al., 2025).

This beginning scenario is intended to offer an authentic learning environment in which students can investigate chemistry-based explanations for the challenges they face in their daily lives. This contextual approach then leads into a discussion of urgent food safety issues, such as the use of formalin (formaldehyde) by some fish dealers as an unlawful preservative a practice that poses substantial health hazards yet staying common in diverse places (Kumar et al., 2023) . According to the teachers, incorporating this topic into the course material achieves many pedagogical goals: introducing students to current and pressing public health issues while also increasing their understanding of chemistry specifically food chemistry in the context of fish preservation. This problem-oriented framework is identical to the case-study-based learning strategy stated in the semester course outline (RPS).

As illustrated in Figure 1, the contextual learning zone is divided into three interconnected modules: The Reality of Food Distribution, Case Study: Field Findings, and Natural Preservative Solutions. This structure exemplifies the CTL principle of presenting information as a process that begins with real-world problems and progresses to science-based solutions, leading students in connecting chemical fundamentals to real-world food safety issues in Indonesia. It is important to note that Figure 1 is a conceptual design prototype developed as a visual representation of the media specifications identified through this needs analysis. This preliminary design has not yet undergone expert validation or empirical testing, and is intended solely to illustrate the structure and learning flow of the proposed media.

Figure 1. Web Interface of the Contextual Learning Zone (Zona Isu Pangan) in the Proposed Canva-Based Interactive Learning Media

This learning approach also paves the way for a logical transition to the recommended solution: natural preservatives extracted from kalamansi peel and oil palm leaves a safe, locally available option that has been empirically validated as an alternative to synthetic chemical preservatives (Imahori et al., 2024; (Harmileni et al., 2024). Following the contextual problem-solution pattern, educators must present core curriculum material on food additives in accordance with RPS provisions, as well as a detailed description of the chemical properties of these natural extracts, including the bioactive compounds that underpin their antimicrobial and antioxidant activities (Jeans et al., 2026; Onakurhefe et al., 2019).

Instructors emphasize the significance of this chemical characterisation part so that students can have a thorough conceptual knowledge of how natural extracts work as preservatives rather than merely accepting this assertion passively. Furthermore, the platform must include a fish freshness detection feature powered by a Convolutional Neural Network (CNN) model, which allows students to upload images of fish samples and receive AI-based predictions about their freshness status based on visual indicators such as the fish's eye condition (Jaydish & Chelladurai, 2026). Figure 2 illustrates the fish freshness detection function included in the suggested media.

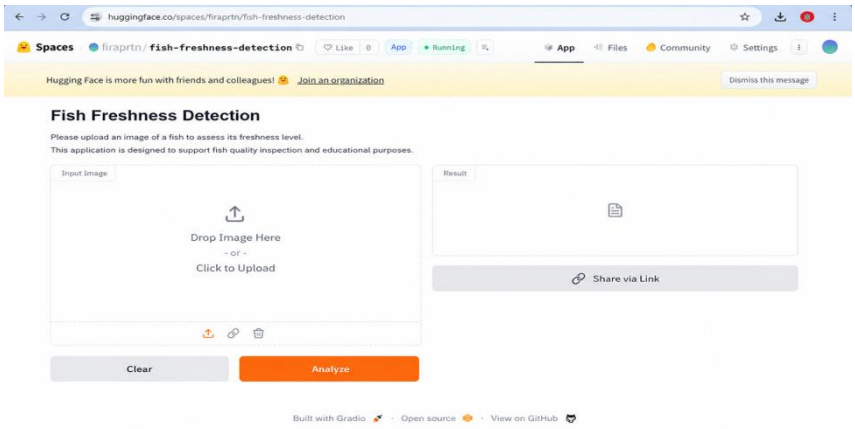

Figure 2. Web Interface of the CNN-Based Fish Freshness Detection Feature Using Eye Condition as Visual Indicator in the Proposed Food Chemistry Interactive Learning Media

Figure 2 illustrates the CNN-based fish freshness detection interface, which serves as the AI-powered learning tool proposed in this study. The use of fish eye condition as a visual indicator has a scientific basis, as eye clarity and corneal transparency are well-established markers of fish freshness and are closely related to

protein denaturation and microbial degradation (Zhang et al., 2022). By engaging with this feature, students are expected to develop analytical thinking skills by connecting visual observations with the underlying chemical processes. Figure 2 presents a conceptual design prototype of the planned CNN-based fish freshness detection feature. Similar to Figure 1, this interface is an early-stage design specification developed based on the findings of the requirements analysis and has not yet undergone expert validation or empirical testing. Figure 2 illustrates the CNN-based fish freshness detection interface, which serves as the AI-supported authentic learning tool proposed in this study.

Table 1 summarizes the main findings from the interview data and document analysis, along with their implications for media development. As presented in Table 1, four interrelated aspects were identified: (1) the inadequacy of current learning media in supporting the demands of CPL-4, (2) the suitability of Canva and the integration of deep learning as an evidence-based solution, (3) detailed media specifications derived from needs analysis, and (4) the expected impact on students' higher-order thinking skills. Collectively, these findings confirm that the development of Canva-based interactive web media integrated with deep learning technology is not only justified by curricular gaps but is also empirically grounded in faculty perspectives and evidence from document analysis.

Table 1. Summary of Key Findings from the Analysis

Aspect	Main Findings	Implication
Learning Media Conditions	Currently available media (e-book, PowerPoint, and conventional textbook) are predominantly text-based, lack interactive and visual elements, and are insufficiently aligned with CPL-4 demands in the RPS	Development of Canva-based interactive web media is urgently needed to bridge the gap between curricular expectations and available learning resources
Suitability of Canva and Deep learning	Lecturers confirmed that Canva's visual and interactive features directly address identified media gaps; the Deep learning-powered fish freshness detection feature contextualizes abstract chemical concepts in real-world food safety assessment	Canva and Deep learning integration provides an evidence-based, contextually grounded solution to the documented inadequacies of current learning media
Media Specifications	Media must follow a contextual learning approach covering: fish distribution problems, formalin misuse, natural preservatives (kalamansi peel and oil palm leaf extract), food additive content, chemical characterization, CNN-based fish freshness detection, Deep learning explanation, and educational game	Develops a complete, locally contextualized, and technologically integrated learning experience that supports HOTS attainment and authentic assessment
Impact on Students	Improved critical, analytical, and innovative thinking through contextual problem-solving and AI-assisted learning activities	Supports strengthening of food chemistry literacy and digital competency among Food Chemistry students

3.2. Discussion

The research findings from semi-structured interviews with course instructors, as well as an analysis of documents such as the Semester Learning Plan (RPS) and the textbook for the Food Chemistry course, provided a comprehensive understanding of the current state of learning media use. This also creates chances for significant growth through the use of technology-based learning media advances. The key strength of this study's methodological strategy is the integration of information from two forms of primary data that complement one another. Semi-structured interviews gave direct insights into the teachers' experiences with available learning media, whilst an assessment of RPS and textbooks provided empirical and objective data representing the real circumstances of these media.

The similarity of findings between these two data sources increases the validity of the research conclusions, which is consistent with the triangulation principle in qualitative research (Hands, 2022). These findings were then interpreted based on the theoretical framework outlined in the introduction, specifically Contextual Teaching and Learning (CTL) and the development of Higher-Order Thinking Skills (HOTS), which serve as the pedagogical foundation for the proposed media specifications

The investigation found that currently accessible learning tools, such as e-books, PowerPoint presentations, and traditional textbooks, have not yet been able to maximize the accomplishment of desired learning outcomes. This pattern is typical in Indonesian institutions, where traditional media continue to dominate despite rising demand for interactive and technology-based media (Farias-gaytan et al., 2023). This gap illustrates the mismatch between the availability of technological infrastructure and the needs of a curriculum that is always evolving as a result of digital age innovations. An analysis of the RPS reveals that there is still tremendous room to improve learning media to better meet these needs.

The positive response to Canva as a platform for developing educational media demonstrates its significant potential as an advanced yet user-friendly tool for instructors, allowing them to create high-quality instructional materials without requiring extensive technical knowledge. These findings are consistent with prior research demonstrating Canva's positive influence on student learning motivation and academic achievement across a variety of educational contexts (Sidauruk et al., 2025). Canva's features, which provide abundant visual content that is adaptable to various devices, effectively address identified accessibility needs while providing instructors with practical solutions to improve the quality of learning materials without burdening them with unnecessary technical complexity (Mina et al., 2024; Jian & Swanto, 2025).

As a conceptual contribution, this study proposes the integration of deep learning through a planned Convolutional Neural Network (CNN)-based fish freshness detection feature, utilizing visual indicators from the fish's eyes. At this stage, the CNN component is more of a design specification than a validated system; its inclusion in the media specification is based on the identified need for authentic, AI-assisted problem-solving experiences in Food Chemistry instruction. Students are expected to upload photos of fish eyes and receive an estimated freshness level from the CNN model, which encourages them to connect visual cues with the underlying chemical dynamics of protein denaturation and microbial activity (Xu, 2024). This conceptual feature aligns with CTL principles that link academic content to real-world professional contexts.

A contextual learning approach is the basic foundation for developing the specifications of the planned learning media. Linking learning materials to real-world situations and local contexts has been found to significantly boost student participation and conceptual comprehension (Suryawati & Osman, 2018). The incorporation of aspects from the local Indonesian context into the suggested medium elevates it from a mere technological breakthrough to a solution that is sensitive to the needs of meaningful learning and founded in the social reality of Indonesian students.

From the standpoint of scientific contribution, the uniqueness of this study lies in the needs assessment and development of specifications for an interactive web-based learning tool using Canva, which explicitly integrates deep learning technology for fish freshness detection in the field of Food Chemistry education at Indonesian universities an issue that has yet to be thoroughly explored in the current literature. This study successfully connects the formal curricular requirements defined in the Course Syllabus with concrete educational media development techniques, while also offering a reusable specification framework to help students acquire critical thinking abilities.

Despite its promising potential, the implementation of the proposed media is not without challenges. From a technical standpoint, the development and deployment of a CNN-based feature requires computational resources, labeled training datasets, and technical expertise that may not be readily available at all institutions. From an institutional perspective, faculty readiness and digital literacy vary significantly across departments, which may affect the adoption and effective utilization of technology-integrated learning media (Simpal & Robles, 2024). Furthermore, internet access reliability among students articularly in non-urban areas of Indonesia remains a practical constraint for web-based learning platforms. These challenges underscore the importance of phased implementation, beginning with expert validation and small-scale pilot testing before broader rollout.

This study acknowledges significant limitations, which must be publicly stated. Because of the small sample size, the findings are constrained to a specific setting, making it difficult to extrapolate to a larger scale. Furthermore, the lack of student participation as responders in data gathering means that their viewpoints are only indirectly reflected through faculty feedback. Furthermore, because this study has only completed the needs analysis phase, the impact of media on student academic achievement cannot yet be experimentally measured. Further research recommendations include: (1) developing a media prototype and validating it with experts; (2) expanding the needs assessment to include students as primary participants; (3) conducting both pilot and large-scale tests to evaluate the utility and impact on learning outcomes; and (4) conducting cross-campus implementation studies to test the media's scalability across various situations and learning contexts.

4. Conclusion

This study has completed a qualitative needs analysis and developed specifications for an interactive web-based learning tool using Canva, integrated with deep learning technology, for the Food Chemistry course. The qualitative approach, which utilized semi-structured interviews and document analysis, yielded two main findings. First, current learning materials are not yet fully aligned with curriculum requirements that emphasize critical and innovative thinking; document analysis revealed a predominance of traditional formats lacking web-based interactive elements and explicit discussion of fish preservation topics. Second, an interactive web-based Canva platform incorporating a CNN-based fish freshness detection feature planned to use fish eye indicators is considered highly suitable for bridging this gap, offering a contextual, visually rich, and technology-supported learning experience. Overall, these findings indicate that the gap between curriculum demands and the

availability of current media is not merely a technical shortfall, but a deeper pedagogical challenge requiring a systemic response that integrates interactive design, authentic contexts, and AI-supported learning tools.

From a theoretical perspective, this study contributes to the evolving literature on educational technology by demonstrating how the principles of Contextual Teaching and Learning (CTL) can be implemented through the integration of Canva-based interactive media and deep learning technologies. Unlike previous studies that explored Canva primarily as a static design tool or AI-assisted learning in general education, this research uniquely situates these technologies within the specific domain of Food Chemistry education at Indonesian universities—a context that has been largely unexplored in the literature. The scientific contribution of this study lies in providing an evidence-based specification framework that bridges formal curriculum requirements with concrete media development guidelines, while offering a replicable model for needs-based media development in other science education fields. Practically, these findings highlight the importance of developing media rooted in local contexts relevant to students' lives, positioning the CNN-based fish freshness detection feature as a conceptual technical learning tool rather than a validated system, and providing operational guidelines for instructors to support effective implementation.

Given that the scope of this study is limited to needs analysis, the effectiveness of the proposed media on learning outcomes cannot yet be evaluated experimentally. Therefore, further research is recommended in the following sequential phases: (1) prototype development and expert validation, focusing on content accuracy, instructional design quality, and the technical feasibility of the CNN components; (2) expansion of the needs assessment to involve students as primary respondents, to ensure the media specifications reflect the learners' perspectives; (3) small-scale usability testing followed by a large-scale pilot study to measure the media's impact on the development of HOTS and learning outcomes; and (4) a cross-campus implementation study to evaluate the media's scalability across various institutions with varying technological infrastructures, particularly in non-urban areas of Indonesia. Through these sequential steps, the Canva-based interactive web-based media integrated with deep learning has the potential to function not only as a digital learning resource but also as a pedagogical tool that strengthens food chemistry literacy and fosters cutting-edge technological competencies in Indonesian higher education contributing significantly to the broader educational transformation agenda in the era of the Fourth Industrial Revolution.

Author Contributions

Fira Pratiwi: Conceptualization, Methodology, Supervision, Writing - Review & Editing. Rendy Wikrama Wardana: Data curation, Formal analysis, Writing - Original Draft. Afrizal Mayub and Nurhamidah: Software, Resources, Visualization, Methodology. M. Lutfi Firdaus: Validation, Investigation, Writing - Review & Editing.

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The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Data Availability

The datasets generated during and/ or analyzed during the current study are available from the corresponding author on reasonable request.

Declaration on AI Use

The authors declare that no artificial intelligence (AI) or AI-assisted tools were used in the preparation of this manuscript.

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