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Effectiveness of the MOWEING (E-Learning Platform) on nutrition students' understanding of nutrition students' cognitive learning outcomes in infectious disease dietetics

Efektivitas platform MOWEING berbasis e-learning dalam meningkatkan hasil belajar kognitif dietetika penyakit infeksi pada mahasiswa gizi

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Abstract

Innovative learning approaches are needed in the Dietetics of Infectious Diseases (DPI) course to overcome the low comprehension of nutrition students caused by conventional modules. This study aimed to evaluate the effectiveness of the Web E-Learning model (MOWEING) in improving students' understanding. This research and development (R&D) study, which used the ADDIE model, involved Class A (n=52) and Class B (n=53). Data were collected through a quasi-experimental pre-test (Mid-Term Exam) and post-test (Final Exam) design and analyzed using a paired-samples t-test. MOWEING implementation was associated with improved cognitive learning. Class A experienced a significant mean score increase from 69.40 to 83.20 ($p<0.001$). Class B also increased significantly from 73.53 to 80.20 ($p=0.012$). The main finding revealed that MOWEING significantly enhanced cognitive outcomes in both classes, although Class A achieved a more homogeneous final score distribution. In conclusion, MOWEING showed potential effectiveness. MOWEING implementation was associated with improved cognitive learning outcomes in both classes. These findings support the further evaluation of MOWEING as a digital learning medium for nutrition education.

Keywords: Cognitive learning outcomes, e-learning, infectious disease dietetics, nutrition education, MOWEING

Abstrak

Inovasi pembelajaran diperlukan pada mata kuliah Dietetika Penyakit Infeksi (DPI) untuk mengatasi rendahnya pemahaman mahasiswa gizi akibat modul konvensional. Penelitian ini bertujuan mengevaluasi efektivitas Model Web *E-Learning* (MOWEING) dalam meningkatkan pemahaman mahasiswa. Penelitian *penelitian dan pengembangan* (R&D) menggunakan model ADDIE ini dilaksanakan di Program Studi Gizi Poltekkes Kemenkes Surabaya dari September 2025 hingga Mei 2026, dengan melibatkan Kelas A (n= 52) dan Kelas B (n= 53). Data dikumpulkan melalui desain eksperimen semu *pre-test* (Ujian Tengah Semester) dan *post-test* (Ujian Akhir Semester), lalu dianalisis menggunakan *uji t berpasangan* Hasil penelitian menunjukkan berpotensi efektif. Penerapan MOWEING berasosiasi dengan peningkatan hasil belajar kognitif mahasiswa. Kelas A mengalami peningkatan nilai rata-rata signifikan dari 69,40 menjadi 83,20 ($p<0,001$). Kelas B juga meningkat signifikan dari 73,53 menjadi 80,20 ($p=0,012$). Temuan utama mengungkapkan bahwa MOWEING secara nyata meningkatkan capaian kognitif di kedua kelas, meskipun Kelas A mencapai sebaran nilai akhir yang lebih homogen. Kesimpulannya, penerapan MOWEING berasosiasi dengan peningkatan hasil belajar kognitif pada kedua kelas. Implikasinya, model ini layak diadopsi sebagai

media pembelajaran digital adaptif guna mendukung pembelajaran kognitif mahasiswa gizi.

Kata Kunci: Dietetika penyakit infeksi, e-learning, hasil belajar kognitif, Pendidikan gizi, MOWEING

Introduction

The rapid development of information and communication technologies in recent years has substantially transformed higher education, including health and nutrition education. This digital transformation has driven a paradigm shift from conventional instructional methods toward web-based learning environments that enable teaching and learning to become more flexible, interactive, adaptive, and accessible regardless of time and location (Adedoyin & Soykan, 2023; Haleem et al., 2022). Electronic learning (E-learning) has emerged as an effective instructional approach for improving the quality of education and learning outcomes in higher education, particularly by facilitating students' understanding of complex course content (García-Morales et al., 2021; Valverde-Berrocoso et al., 2021).

As stipulated in the Infectious Disease Dietetics in Nutrition Care Practice module and the AIPGI curriculum, clinical nutrition care is a core competency that nutrition students must acquire. This competency is developed intensively through the Infectious Disease Dietetics course across three progressively structured domains. At the cognitive level, students are expected to understand the pathophysiology of diseases, metabolic alterations, and immune responses. This theoretical knowledge subsequently provides the foundation for developing clinical reasoning, through which students must analyze the complex interactions between the progression of infectious diseases and the deterioration of nutritional status to establish specific nutrition diagnoses. Ultimately, this reasoning culminates in practical competence, namely the ability to formulate precise dietary prescriptions and interventions in accordance with the standardized Nutrition Care Process (NCP). The content of Infectious Disease Dietetics requires students to continuously transition from theoretical concepts to clinical reasoning and practical application, which often presents considerable learning difficulties (Banna et al., 2021). These challenges are further intensified when classroom instruction remains conventional, monotonous and entirely teacher-centered. Such one-way instructional practices restrict opportunities for independent exploration, ultimately limiting deep and meaningful learning and weakening students' analytical ability to address authentic clinical cases encountered in practice (Sari et al., 2022; Sukmawati & Wardani, 2023).

The discrepancy between curriculum-based competency requirements and classroom realities is clearly reflected in the academic performance of nutrition students in the study. According to baseline grade records collected before the digital learning intervention, students' understanding of Infectious Disease Dietetics remained suboptimal. The mean midterm examination scores were only 69.40 in Class A and 73.53 in Class B, both of which were below the minimum passing grade of 79.9 established by the program. Midterm examination scores were used as baseline pretest measures because the assessment instrument had been tested for validity and reliability and was developed using a test blueprint and cognitive levels equivalent to those of the final posttest instrument, specifically levels C2–C4 of Bloom's taxonomy. The alignment of the indicators and difficulty levels across the instruments ensured their comparability, allowing changes in learning outcomes to validly reflect the effects of the intervention. These low baseline scores underscore the urgent need to modernize learning and assessment systems by incorporating educational media that can help students translate abstract concepts into concrete and accessible visual representations.

Previous research has empirically demonstrated that web-based e-learning platforms can increase student engagement, diversify learning resources, and continuously foster self-directed learning (Dhawan, 2022; Singh et al., 2021). By integrating multimedia technologies, including structured instructional videos, interactive clinical simulations, digital case studies, and automated quizzes, previously abstract concepts related to the pathophysiology

of infectious diseases can be presented in a more visual and contextualized format. Recent evidence further indicates that well-designed digital learning ecosystems can improve not only cognitive learning outcomes but also students' intrinsic motivation and critical thinking skills (Pei & Wu, 2021; Radha et al., 2021).

Although digital learning has been widely implemented in higher education, its application in nutrition education faces several challenges. Commonly used learning management systems (LMSs), such as Moodle and Canvas, generally provide tools for course management, content distribution, discussion forums, and online assessments. However, these platforms are generic and therefore require customization to accommodate the distinctive characteristics of Infectious Disease Dietetics, which requires students to integrate foundational concepts, analyze clinical data, and make decisions throughout the nutrition care process. Furthermore, instructional videos, quizzes, discussion forums, and case studies on existing platforms generally function as separate features rather than components of an integrated learning pathway designed to progressively develop students' clinical reasoning (Nugroho et al., 2023; Bahadoran et al., 2018). These limitations indicate an unmet need for digital learning media specifically designed to address the instructional characteristics of Infectious Disease Dietetics.

To address this gap, the present study developed the Model Web E-Learning (MOWEING), a web-based learning medium systematically designed using the ADDIE model, which comprises analysis, design, development, implementation, and evaluation (ADDIE). The novelty of MOWEING lies not only in its use of a digital platform but also in its integration of interconnected learning features within a unified instructional pathway. These features included digital modules, instructional videos, formative assessments delivered through Google Forms, content reinforcement through educational games using Wordwall, discussion forums, and case-based learning using the Nutrition Care Process. This pedagogical integration was designed to promote active learning, provide continuous feedback, and facilitate students' ability to connect theoretical concepts with clinical case management skills. Accordingly, MOWEING is expected to improve student engagement, conceptual understanding, and analytical skills in Infectious Disease Dietetics. Through the implementation of this integrated model, MOWEING is also expected to provide an adaptive alternative for reducing gaps in students' understanding of dietary management for infectious disease. Its effectiveness was examined based on the hypothesis that the MOWEING platform would significantly and consistently improve nutrition students' understanding, as demonstrated by increased post-intervention scores and optimal normalized gain values. Therefore, this study aimed to develop and assess the feasibility of MOWEING and evaluate its effectiveness in comprehensively improving nutrition students' understanding of Infectious Disease Dietetics.

Methods

This study used a research and development (R&D) approach based on the ADDIE model, which comprises analysis, design, development, implementation, and evaluation of the learning process. This model was selected because its systematic and highly adaptable structure facilitates the development and effectiveness testing of the Model Web E-Learning (MOWEING), a web-based digital learning medium for the Infectious Disease Dietetics course. To evaluate the potential of MOWEING to improve students' understanding, a pre-experimental one-group pretest–posttest design was applied independently to two parallel classes. Midterm examination scores were used as indicators of baseline ability (pre-test), whereas final examination scores were used as indicators of learning outcomes after the implementation of MOWEING (post-test). Applying the same intervention to two parallel classes allowed for the examination of the consistency and replicability of the learning outcomes. This approach was intended to determine whether MOWEING produced similar and reliable improvements in students' understanding across groups with different learning dynamics.

The study was conducted in the Nutrition Study Program at the Health Polytechnic of the Ministry of Health, Surabaya. Needs analysis began in September 2025 and was followed by design, platform development, and expert validation stages, which continued through May 2026. Model implementation and the collection

of pre- and post-test data were conducted throughout the second semester of the corresponding academic year.

The study population comprised all active students in the Diploma III Nutrition Study Program who were enrolled in the Infectious Disease Dietetics course. Participants were selected using purposive sampling based on parallel classes attending the course during the study semester. The sample size was determined by calculating the minimum number of participants required to compare the mean learning outcomes using a mean difference approach aligned with the study objectives. The resulting sample size met the minimum statistical requirements for evaluating changes in students' learning outcomes before and after MOWEING implementation.

The operational stages of MOWEING development and effectiveness testing are presented schematically using a modified ADDIE framework (Cheung, 2016), as shown in Figure 1.

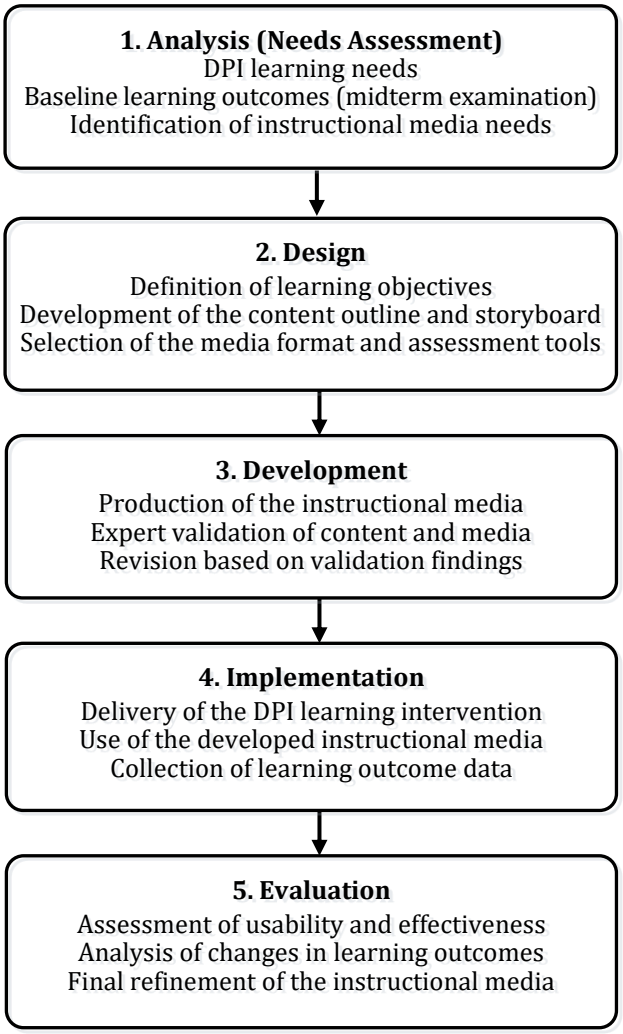

Figure 1. ADDIE framework

The primary outcome examined in this study was the students' level of understanding of Infectious Disease Dietetics. Data were collected using objective, case-based, multiple-choice tests derived from authentic clinical cases. The instruments were tested for validity and reliability. Baseline cognitive data were obtained from midterm examination scores, whereas post-intervention cognitive data were obtained from final examination scores after the full implementation of MOWEING.

All data were processed digitally using SPSS and analyzed using systematic descriptive and inferential procedures. First, descriptive statistics were calculated, including the mean and standard deviation (SD) of midterm and final examination scores. This analysis was performed to describe trends in students' cognitive understanding and the distribution of scores within each intervention group.

Second, inferential analysis was conducted to evaluate changes in students' learning outcomes before and after MOWEING implementation within each class. Before hypothesis testing, data distributions were assessed using the Shapiro–Wilk test. As the data met the assumption of normality, changes in learning outcome scores within each class were analyzed using a paired-samples *t-test* at a 5% significance level ($\alpha = 0.05$). The results were reported as means, standard deviations, mean differences, *t-statistics*, degrees of freedom (*df*), *p-values*, 95% confidence intervals (95% CIs), and effect sizes (Cohen's *d*) to quantify the magnitude of change following the implementation of MOWEING. This analysis was intended to evaluate changes in learning outcome scores within each class and was not used to compare the patterns of change between classes.

This study adhered to the ethical principles of health education research. All participating students received an explanation of the study objectives and voluntarily provided written informed consent. Participant identities and data were kept confidential, and anonymity was maintained throughout the study period.

Result and Discussion

A total of 105 nutrition students completed the study, comprising 52 students in Class A and 53 students in Class B, with a 100%

completion rate. Baseline characteristic analysis indicated that the two classes had relatively homogeneous profiles. Most students were 20 years old, female, and enrolled in their fifth semester of study. Regarding technological readiness, all students had previous experience using e-learning platforms, primarily through laptops or smartphones, and had adequate access to the campus Internet network.

Table 1. Descriptive and inferential analyses of students' learning outcome scores

Group	n	Assessment Stage	Mean	Standard Deviation (SD)	Mean Difference	95% CI
Class A	52	Midterm examination (before)	69.4	11.25	13.27	10.35–16.18
		Final examination (after)	83.2	6.48		
Class B	53	Midterm examination (before)	73.53	14.12	9.49	6.10–12.87
		Final examination (after)	80.2	15.65		

As shown in Table 1, the mean scores increased from pre-test to post-test in both intervention classes. To visually illustrate the distribution and overall pattern of improvement in learning outcomes across Classes A and B, the score patterns are shown in Figure 2.

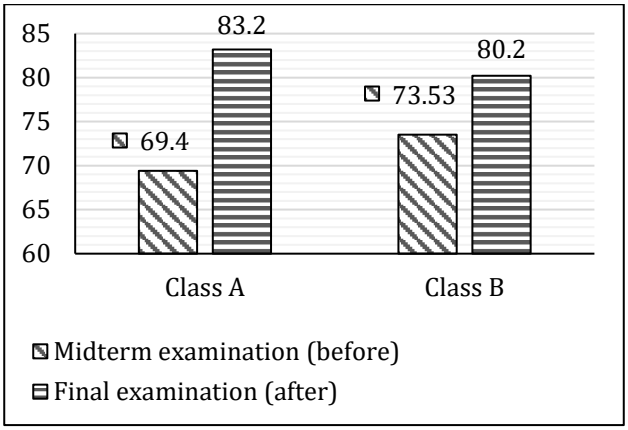

Figure 2. Comparison of mean midterm (before) and final (after) examination scores between Classes A and B.

Table 2. Significance tests for within-class changes and between-class differences in learning outcome scores

Comparison Group	Mean Difference	p-value
Class A: Midterm vs. final examination	13.8	< 0.001*[a]
Class B: Midterm vs. final examination	6.67	0.012**[a]
Class A vs. Class B: Posttest/final examination	3	0.034**[b]

*p<0.001; **p<0.05. [a]Paired-samples t-test. [b]Independent samples t-test.

The paired-samples t-test results presented in Table 2 demonstrate statistically significant increases in midterm to final examination scores in both Class A ($p < .001$) and Class B ($p = .012$). However, because these analyses assessed score changes within each class without a true control group and used midterm and final examinations that were not fully equivalent, the observed improvements cannot be causally attributed solely to MOWEING. External factors, including student maturation, differences in examination content and difficulty, instructor-related factors, and other learning exposures, may have also influenced the score changes. The independent-samples t-test of posttest scores indicated a statistically significant difference in the final mean scores between Classes A and B ($p = .034$).

These findings indicate that the implementation of the Model Web E-Learning (MOWEING) was associated with improved learning outcomes in the Infectious Disease Dietetics course. The increased mean scores observed in both classes suggest that MOWEING may support learning by integrating digital modules, instructional videos, Google Forms–based formative assessments, educational games delivered through Wordwall, discussion forums, and systematically structured case study activities. These features may help students visualize complex pathophysiological concepts and the Nutrition Care Process (NCP), thereby facilitating comprehension and promoting active engagement and self-directed learning (Adedoyin & Soykan, 2023; Dhawan, 2022).

Nevertheless, the observed improvements cannot be entirely attributed to MOWEING.

Changes in scores may also have been influenced by differences in content coverage between the midterm and final examinations, the accumulation of learning experiences throughout the semester, increased learning motivation, interaction with instructors and peers, and variations in access to and use of educational technologies. Therefore, these findings should be interpreted cautiously as evidence of an association suggesting the potential contribution of MOWEING to improved learning outcomes, rather than as causal evidence that the intervention alone produced all observed score increases.

Theoretically, the tendency toward greater variation in scores may be related to individual differences in technological adaptation, digital literacy, and self-regulated learning. Students with greater motivation and discipline for independent study may have been better able to explore the case-based modules available through MOWEING, whereas students requiring additional guidance may have experienced greater difficulty in adapting to the platform (Banna et al., 2021; Sukmawati & Wardani, 2023). However, because digital literacy and self-regulated learning were not measured directly, this interpretation should be regarded as a possible explanation that requires further investigation.

Compared with previous research in nutrition and dietetics education, the present findings demonstrate a consistent pattern, suggesting that integrating digital learning media with a case-based approach may improve students' cognitive learning outcomes. Learning outcome scores increased in both classes following the implementation of MOWEING, although the magnitude of improvement differed. This finding is consistent with Sari et al. 's (2022) report that case-based dietetics instruction integrated into a digital platform was associated with stronger analytical skills among nutrition students than conventional lecture-based instruction. Similarly, García-Morales et al. (2021) and Valverde-Berrocoso et al. (2021) emphasized that the effectiveness of e-learning depends on a platform's ability to facilitate students' active engagement in the learning process.

The contribution of MOWEING to Infectious Disease Dietetics education lies in its integration of digital modules, instructional videos, Google Forms–based formative assessments, Wordwall educational games, discussion forums, and NCP-based case resolution within a unified learning pathway that supports both conceptual understanding and clinical application. However, the findings were obtained from students enrolled in a Diploma III Nutrition Study Program at a single educational institution; therefore, their generalizability to other programs or institutions should be considered cautiously. Studies involving more diverse populations and stronger research designs are required to confirm the consistency of these findings and strengthen the evidence regarding the potential use of MOWEING in Infectious Disease Dietetics education.

Overall, the findings support the proposed hypothesis that the implementation of MOWEING was associated with increased cognitive learning outcome scores among students enrolled in Infectious Disease Dietetics. However, because the study used a pre-experimental design without a true control group, these results should be interpreted as preliminary evidence of MOWEING's potential to support learning, rather than as definitive evidence of a causal relationship.

This study had several limitations that should be considered when interpreting the findings. Although an R&D approach based on the ADDIE model was used to develop and evaluate MOWEING, its effectiveness was assessed using a pre-experimental one-group pretest–posttest design implemented in two parallel classes without a control group. Consequently, the observed changes in learning outcomes before and after MOWEING implementation cannot be attributed entirely to the intervention, because factors unrelated to platform use may also have contributed to these changes.

Furthermore, midterm and final examination scores were used as indicators of baseline ability and final learning achievements, respectively. However, both were routine academic assessments and were not specifically designed as fully equivalent pre- and post-test instruments. Differences in content coverage, competency indicators, and item difficulty may have affected the students'scores. The study also could not fully control for maturation effects, namely, the natural improvement in students' abilities over one semester through lectures, discussions, assignments, and independent study.

In addition, the intensity of each student's use of MOWEING outside the scheduled class hours was not objectively monitored. Therefore, the relationship between the extent of platform

use and improvement in learning outcomes could not be comprehensively evaluated. Consequently, these findings should be regarded as preliminary evidence of MOWEING's potential to support learning. The causal relationship between MOWEING use and improved learning outcomes requires confirmation through studies employing stronger designs, such as randomized controlled trials or quasi-experimental studies with an equivalent control group.

Conclusion

The implementation of Model Web E-Learning (MOWEING) demonstrated the potential to support improvements in students' cognitive learning outcomes in Infectious Disease Dietetics. MOWEING use was associated with increased learning outcome scores in both classes, although the magnitude of improvement differed between the two classes. Class A showed moderate improvement with relatively homogeneous score distributions, whereas Class B showed low improvement with greater variability in the scores. Given the pre-experimental design without a control group and the use of midterm and final examination scores as pre- and post-intervention indicators, these findings should be regarded as preliminary evidence of MOWEING's educational potential rather than evidence of causality.

MOWEING may serve as an alternative digital learning medium for Infectious Disease Dietetics. Future studies should employ an equivalent control group or a more rigorous experimental design to provide more valid evidence of effectiveness. Implementation fidelity, including platform use intensity, student engagement, and adherence to the learning pathway, should also be monitored to enable a more comprehensive evaluation of the relationship between MOWEING and learning outcomes.

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018

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