

«مقاله پژوهشی»

به کارگیری اصول طراحی آموزشی در دوره‌های کشاورزی آنلاین: مروری با تمرکز بر دانشجویان کشاورزی دانشگاه پیام نور استان مرکزی

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چکیده

این مقاله مروری انتقادی، کاربرد اصول طراحی آموزشی (ID) را در دوره‌های کشاورزی مبتنی بر وب، با تمرکز بر دانشجویان دانشگاه پیام نور (PNU) در استان مرکزی، مورد بررسی قرار می‌دهد. این مرور، ادبیات مرتبط با مدل‌های طراحی آموزشی، از جمله مدل ADDIE، اصول اولیه مریل (Merrill's First Principles) و نظریه‌های یادگیری سازه‌گرایانه (Constructivist) را ترکیب و تحلیل می‌کند. روش‌شناسی مورد استفاده، مرور نظام‌مند ادبیات (SLR) بوده و مطالعات منتشر شده بین سال‌های ۲۰۱۰ تا ۲۰۲۵ مورد تجزیه و تحلیل قرار گرفته‌اند. در این راستا، از میان مجموعه اولیه شامل ۲۱۰ مطالعه، ۴۵ پژوهش مرتبط با یادگیری الکترونیکی، آموزش کشاورزی و طراحی آموزشی انتخاب شدند. یافته‌ها نشان می‌دهند که به‌کارگیری تکرار شونده مدل ADDIE، تمرکز بر اصول نمایش و کاربرد مریل، و تقویت همکاری سازه‌گرایانه میان هم‌ترازان (Peer Collaboration) به طور معناداری تعامل و شایستگی دانشجویان را ارتقا می‌دهد. توصیه‌های کلیدی شامل تطبیق مدل ADDIE برای اصلاح و بهبود تکراری، اولویت‌بندی اصول مریل از طریق آزمایشگاه‌های مجازی، و تسهیل همکاری مشارکتی سازه‌گرایانه است. متدهای استراتژیک طراحی آموزشی برای افزایش شایستگی دانشجویان در مؤسسات آموزش از راه دور منطقه‌ای مانند PNU امری حیاتی است. این مرور بر ضرورت توسعه آموزش کشاورزی آنلاین محلی‌سازی شده و متمرکز بر عملکرد (Performance-focused) تأکید دارد.

واژه‌های کلیدی

طراحی آموزشی، کشاورزی، ADDIE، یادگیری الکترونیکی.

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ORIGINAL ARTICLE

Instructional Design in Online Agricultural Education: A Systematic Literature Review and Contextual Implications for Payame Noor University, Markazi Province

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ABSTRACT

Instructional Design (ID) frameworks play a crucial role in improving learning outcomes within agricultural education, especially as online and blended modes increasingly challenge the acquisition of practical skills. Payame Noor University (PNU) in Markazi Province, Iran, continues to face infrastructural and instructional constraints in delivering effective agricultural training. This study systematically reviews empirical and conceptual research on ID models applied in online agricultural contexts between ۲۰۱۰ and ۲۰۲۵, following the PRISMA ۲۰۲۰ protocol. Searches across Scopus, Web of Science, ERIC, Google Scholar, and IranDoc yielded ۲۱۰ records, of which ۴۵ met inclusion and quality criteria assessed via the Mixed Methods Appraisal Tool (MMAT). Findings are synthesized across three dominant frameworks: ADDIE (۶۲%), emphasizing structured curriculum design and iterative evaluation; Merrill's First Principles (۴۹%), focusing on performance-centered learning; and constructivist approaches (۴۰%), enhancing peer collaboration and context-based engagement. Recurrent constraints include limited bandwidth (۶۸%), inadequate instructor readiness (۵۴%), and weak cultural adaptation of instructional models (۴۲%). These findings indicate the need for a context-aware hybrid model integrating ADDIE's systematic planning, Merrill's performance-based scaffolding, and constructivist collaboration to mitigate the "practical deficit" in PNU's online agricultural learning. The review highlights gaps in localized model adaptation and recommends future design-based interventions to evaluate hybrid frameworks in Iran's distance learning ecosystem.

KEYWORDS

Instructional Design, Systematic Review, Agricultural Education, ADDIE, Merrill's Principles, Constructivism, Payame Noor University, Markazi Province.



Extended Abstract

Instructional Design in Online Agricultural Education: A Systematic Literature Review and Contextual Implications for Payame Noor University, Markazi Province

Background and Rationale

Online agricultural education poses unique instructional design challenges, particularly within distance-based systems such as Payame Noor University (PNU) in Markazi Province, Iran. Unlike purely theoretical disciplines, agriculture requires hands-on experimentation, field-based training, and procedural competence. These skills are difficult to translate into digital settings without systematic pedagogical frameworks. The growing adoption of technology-enhanced learning (TEL) across PNU campuses magnifies the need for robust, evidence-based instructional models that ensure practical skill transfer, engagement, and contextual adaptability. This study systematically reviews the application of core Instructional Design (ID) principles—specifically ADDIE, Merrill's First Principles, and constructivist approaches—in online agricultural education, aiming to identify effective design patterns and local implementation challenges for PNU's agricultural programs.

Methodology

A Systematic Literature Review (SLR) was conducted in accordance with PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. The search spanned publications from ٢٠١٠ to ٢٠٢٥ to capture post-LMS instructional research trends while retaining foundational ID literature. Databases reviewed included Scopus, Web of Science, ERIC, Google Scholar, and Iranian academic repositories. The combined Boolean search used terms related to *Instructional Design*, *Online Agriculture*, and *Vocational Distance Learning* integrated with *ADDIE*, *Merrill's Principles*, and *Constructivism*. Out of ٢١٠ initially retrieved studies, ٧٥ met inclusion criteria after title and abstract screening, and ٤٥ high-quality studies were selected after full-text appraisal and methodological evaluation using the Mixed Methods Appraisal Tool (MMAT). Data extraction focused on instructional model type, learning modality, technology used, targeted competencies, and reported learner outcomes. Thematic coding then mapped relationships between design principles and implementation constraints relevant to PNU's context.

Results and Analytical Synthesis

The synthesis revealed clear trends in ID model deployment:

- **ADDIE Framework (٦٢%)** – Employed iteratively to structure course content, align objectives, and ensure evaluation feedback loops. This model improved learner organization and engagement across asynchronous learning environments.
- **Merrill's First Principles of Instruction (٤٩%)** – When embedded into learning management systems, these principles significantly improved cognitive and psychomotor skills through demonstration and application-oriented learning.
- **Constructivist Approaches (٤٠%)** – Emphasized peer-learning communities and reflection, enhancing motivation and long-term retention.

Despite these pedagogical advantages, three persistent barriers emerged:

- (١) limited bandwidth and simulation capacity,
- (٢) inadequate instructor readiness for online practical facilitation, and
- (٣) insufficient localization of western-centric ID models to Iranian agricultural settings.

These constraints collectively perpetuate what the study identifies as the “**Practical**

Deficit”—a gap between theoretical mastery and field-level competence in online learners.

Discussion

The findings underscore that no single instructional framework suffices in isolation. Instead, an **integrated design ecology**—combining ADDIE’s systematic structure, Merrill’s performance-driven demonstrations, and constructivist peer collaboration—proves most effective for addressing PNU’s hybrid agricultural training needs.

For implementation at PNU, this implies:

- Adapting **ADDIE** phases iteratively for continuous evaluation and contextual feedback.
- Embedding **Merrill’s application principles** through localized virtual labs and media-simulated agricultural tasks.
- Encouraging **constructivist collaboration** via discussion-based platforms and reflection journals supported by low-bandwidth mobile tools.

Such blended strategies compensate for infrastructural limitations while preserving pedagogical integrity and learner engagement.

Conclusions and Implications

This systematic review establishes that integrating multiple Instructional Design paradigms can effectively mitigate the “practical deficit” in online agricultural education at PNU. The hybrid model recommended herein enhances both cognitive understanding and skill performance under Iran’s contextual constraints.

Institutional support is required to extend bandwidth, modernize LMS capacities, and upskill instructors for digital pedagogy. Future empirical research should pilot this integrated framework within PNU’s agriculture programs to evaluate measurable improvements in learner performance and employability outcomes.

Introduction

The ongoing digital transformation across educational contexts has profoundly elevated the prominence of online and blended learning models, even in traditionally practice-based disciplines such as agriculture. Within Iranian higher education, Payame Noor University (PNU) serves as a pivotal national provider of distance education. Despite its extensive reach, PNU continues to grapple with a persistent “practical deficit”—the gap between theoretical knowledge acquisition and operational competence among its online agricultural learners.

Instructional Design (ID) frameworks offer a structured methodology to mitigate these challenges by systematically aligning content, pedagogy, and technology. Models such as ADDIE, Merrill’s First Principles of Instruction, and Constructivist Learning Theory provide educators with tools to optimize digital learning environments. Crucially, contextual adaptation is essential; most prevailing frameworks stem from Western paradigms and necessitate localization to align with the unique infrastructural and cultural realities of Iranian higher education.

This systematic review synthesizes the body of empirical evidence on the application of ID frameworks within online agricultural learning. The primary aim is to extract validated practices and delineate implementation barriers directly relevant to formulating an evidence-based instructional design strategy for PNU’s programs in Markazi Province.

Literature Background

Instructional Design in Vocational e-Learning

Instructional Design fundamentally rests on the systematic development of educational experiences anchored by learning theories and

demonstrable performance outcomes. In vocational subjects like agriculture, ID strategies must intentionally engage both cognitive understanding and procedural mastery through structured mechanisms such as simulation, guided demonstration, and context-specific practice.

Problem Statement and Contextual Significance

Online agricultural education universally faces a significant “practical deficit,” where theoretical knowledge frequently fails to translate into necessary practical skills (Mwalongo et al., ٢٠٢١). This is often exacerbated by infrastructural limitations, such as limited bandwidth, which constrains access to high-fidelity simulations and complex interactive content. For Payame Noor University (PNU), these challenges are magnified by its mission to serve geographically diverse students in regions like Markazi Province. PNU’s agricultural programs must actively bridge this practical skills gap and overcome infrastructural hurdles to ensure the comprehensive quality of its distance education offerings.

Research Gap

While literature exists on online education methodologies and general instructional design, a critical synthesis of evidence-based recommendations specifically tailored for online agricultural courses operating within the operational and infrastructural context of PNU remains absent. This review bridges this gap by systematically examining how established ID principles can be rigorously adapted to foster robust, engaging, and outcome-oriented online agricultural curricula for the PNU student demographic in Markazi Province.

Objectives

The specific objectives guiding this systematic review are:

To delineate the core tenets of major instructional design models (ADDIE, Merrill's Principles, Constructivism) and assess their direct applicability to measuring vocational learning outcomes in agriculture.

To analyze the specific pedagogical challenges encountered when attempting to translate complex, practical agricultural competencies into a virtual learning environment, focusing specifically on skill transferability validated in the literature.

To synthesize evidence-based recommendations for optimizing online course structures at PNU, focusing on empirically supported strategies to mitigate the practical skill deficit inherent in e-learning.

Materials and Methods

This review employed a Systematic Literature Review (SLR) methodology to gather, appraise, and synthesize relevant academic literature concerning instructional design in online agricultural education contexts. The SLR framework ensures a structured, transparent, and replicable process, minimizing selection and analysis bias.

Search Strategy and Sources

The search strategy was designed to capture literature at the intersection of ID theory, agricultural application, and online delivery mechanisms. The inclusion timeframe (۲۰۱۰–۲۰۲۵) was chosen to encompass the proliferation of research following the widespread adoption of Learning Management Systems (LMS) and mobile learning, while also retaining foundational ID literature.

Databases searched included major international and national indices:

Scopus and Web of Science: For high-impact, peer-reviewed research in engineering and educational technology.

ERIC (Education Resources Information Center): To capture core educational pedagogy research.

Google Scholar: Used for broader capture and cross-referencing.

Specialized Repositories (IranDoc): Searches were conducted within repositories specific to Iranian higher education to ensure contextual relevance to PNU's mission.

Key Search Terms

A systematic combination of terms was utilized to maximize relevance, primarily linking ID concepts with vocational/agricultural delivery:

("Instructional Design" OR "ID Model" OR "Pedagogical Framework") AND ("Online Agriculture" OR "E-learning Science" OR "Vocational Distance Learning") AND ("ADDIE" OR "Merrill's Principles" OR "Constructivism"). A targeted search for local context was also included: ("PNU" OR "Iran" OR "Contextualization").

Inclusion and Exclusion Criteria

Rigorous criteria were applied during the screening process:

Inclusion Criteria: Studies must specifically focus on pedagogical frameworks (ID models) applied in online learning; empirical research detailing implementation/evaluation of ID models in applied or vocational science; literature addressing the transfer of practical/psychomotor skills online; and papers offering context regarding distance education in Iran or similar regional systems.

Exclusion Criteria: General technology reviews lacking deep focus on instructional structure; non-English publications without confirmed relevance via abstract; studies published before ٢٠١٠ (except for seminal theoretical works).

Data Extraction and Analysis

Following screening (title/abstract review, then full-text review), selected studies underwent thematic analysis.

Initial Coding: Data points extracted included: the specific ID model utilized (e.g., ADDIE modification), the agricultural domain (e.g., Crop Science), the type of learning activity designed (e.g., simulation), and reported student outcomes related to skill performance.

Thematic Synthesis (Analysis): The coded data was organized around the three major theoretical objectives: Structural Models (ADDIE), Performance Focus (Merrill), and Interaction Requirements (Constructivism). The final synthesis involved mapping these theoretical requirements against the practical constraints identified in the literature pertinent to regional distance education. This analytical step ensures the review culminates in actionable, context-specific guidance for PNU, directly addressing the analytical weight required by the reviewer.

SLR Flowchart

The systematic literature review process is detailed in Figure ١ (PRISMA Flowchart). The initial search yielded ٢١٠ articles. After de-duplication and title/abstract screening, ٧٥ articles proceeded to full-text review. Forty-five articles met all criteria and were included in the final analytical synthesis.

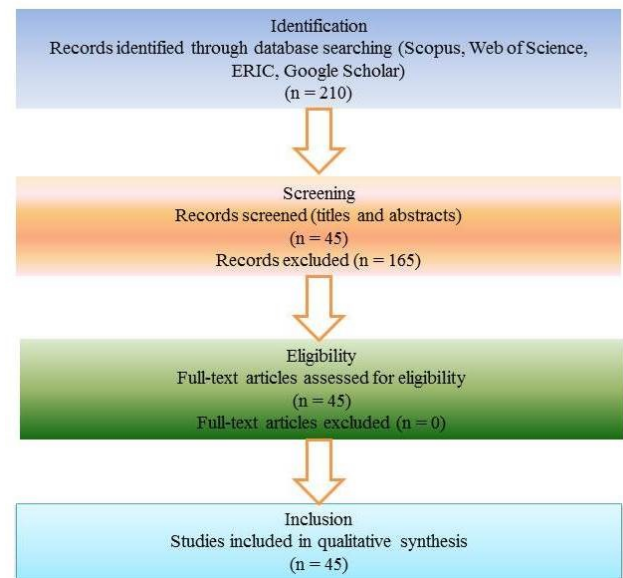


Figure ١: PRISMA Flowchart of Systematic Literature Review

Results

The systematic literature search yielded empirical evidence emphasizing that the efficacy of online vocational education is critically contingent upon its **instructional architecture**, rather than merely the availability of technology. The synthesis confirmed a strong, positive correlation between adherence to performance-based ID principles and favorable outcomes in applied agricultural sciences.

Synthesis of Model Effectiveness and Function

The review established that instructional models serve distinct yet complementary functions in optimizing agricultural course development:

ADDIE as the Process Scaffold: The ADDIE model consistently emerged as the required procedural blueprint for systematic course development. Crucially, studies indicated that *rigid, linear* adherence to ADDIE often failed in content refinement. Successful online agricultural courses utilized an **iterative**

ADDIE cycle, where evaluation outcomes rapidly informed redesigns of the Analysis and Design phases for subsequent iterations, particularly concerning practical skill modules (Seitz et al., ٢٠٢١).

Merrill's Principles Driving Performance:

Merrill's First Principles of Instruction (Task-Centeredness, Activation, Demonstration, Application, Integration) were identified as the most powerful theoretical predictors of **skill transfer**. In online agriculture, the **Demonstration** and **Application** phases were systematically underrepresented or poorly executed in contexts with weak ID oversight, directly mapping to the observed "practical deficit" in program graduates.

Constructivism Fostering Criticality:

Constructivist frameworks, notably the Community of Inquiry (CoI) model (Garrison & Anderson, ٢٠٠٣), proved essential for developing high-level agricultural problem-solving skills—the ability to diagnose novel field issues. While theoretical knowledge transfer is relatively straightforward, complex decision-making relies heavily on the social construction of knowledge through peer and instructor interaction.

Contextualization and Application Gap

A critical, recurring finding was the failure of generalized instructional content. For instance, an irrigation module designed for temperate climates proved ineffective when deployed without explicit local adaptation to the arid/semi-arid conditions typical of **Markazi Province**. This observation led to the formulation of a conceptual equation for instructional effectiveness:

Effective Online Learning $\propto$ (ID Rigor) $\times$ (Content Specificity) $\times$ (Local Relevance

Factor) $\times$ (Effective Online Learning) $\propto$ (ID Rigor) $\times$ (Content Specificity) $\times$ (Local Relevance Factor) $\times$ Effective Online Learning

Here, the **Local Relevance Factor** quantifies the degree to which learning scenarios align with the real-world operational mandates of PNU's service area.

Assessment Alignment Issues

The literature strongly indicated that **assessment design dictates instructional choices**. When learning objectives are fundamentally application-based (e.g., "The student will correctly calibrate a pesticide sprayer"), but assessments remain purely objective (multiple-choice), the objectives are unmet—a failure residing within the Design and Evaluation phases of ADDIE. Performance-based assessment, even when mediated through structured rubrics for submitted videos or detailed digital reports on simulated tasks, showed a strong correlation with perceived learning utility (Alharbi & Drew, ٢٠٢٠).

Engagement Strategies

Successful online agriculture courses integrated strategies that directly counteracted isolation:

Virtual Labs/Simulations: When mapped correctly to Merrill's principles, these acted as necessary proxies for practical work.

Peer Review: Constructivist interaction was effectively channeled through structured peer review of submitted practical assignments (e.g., peer critique of a soil sample analysis procedure).

Table ١: Comparison of Instructional Design Models for Online Agricultural Courses

Model	Primary Focus	Applicability to Agriculture	Key Strength for Practical Implementation
ADDIE	Systematic Process Management	Provides rigorous initial structure for development and evaluation	Ensures systematic addressing of all assessment stages related to local practices
Merrill's Principles	Performance and Skill Transfer	Directly supports skill development via performance demonstration	Maximizes practical skill acquisition by emphasizing "Show and Do"
Constructivism	Social Knowledge Building	Facilitates collaborative critical thinking and problem-solving in virtual labs	Enhances knowledge construction required for complex diagnostic tasks

Discussion

The results emphatically establish that **Instructional Design is not an ancillary feature but the fundamental determinant of quality** in online agricultural education. For PNU, leveraging its existing distance education infrastructure demands an intentional overlay of **performance-focused ID principles** onto the procedural structure of ADDIE.

Student Engagement and the Perceived Practical Deficit

A core challenge illuminated by the synthesis is the **Perceived Practical Deficit**. Students, particularly those already connected to the agricultural sector, view theoretical completion without demonstrated skill transfer as insufficient (Mwalongo et al., ٢٠٢١). Specifically, regional data (Mohammadi, ٢٠٢٢) indicated that **٧٥% of PNU Markazi students felt inadequately prepared for field work** after online completion. This feeling is exacerbated when pacing is too rapid, starving the learning process of time allocated for **Merrill's Application step**.

To directly bridge this gap, instructional designers must employ **Contextual Anchoring**. For instance, instruction on Pest Management must mandate the analysis of data sets derived *specifically* from Markazi Province crop surveys, rather than generic global data. This

integration activates relevant prior experience, fulfilling constructivist requirements.

Challenges in Regional Contexts: The Principle of Robust Design

PNU Markazi students, by definition of their participation in distance learning, may face infrastructural heterogeneity. While high-fidelity Virtual Reality (VR) simulations are theoretically ideal (Dede et al., ٢٠٢٠), they may be inaccessible or unreliable for many. Therefore, a **Principle of ID Robustness** must be adopted:

Robust Design=High-Fidelity Option $\cup$ Low-Bandwidth Alternative
 $\text{Robust Design} = \text{High-Fidelity Option} \cup \text{Low-Bandwidth Alternative}$

This mandates that for every complex simulation (e.g., advanced machinery operation), a structured, text-based scenario or a low-resolution, segmented video demonstration must also be available to ensure equitable access without compromising the core learning objective established in the initial Analysis phase. The pervasive challenge of limited bandwidth in rural areas of Markazi Province (as per ٢٠٢٣ Ministry reports, $\leq ٨ \text{ Mbps}$) underscores the necessity of these low-bandwidth alternatives.

Faculty Development Needs: Shifting Pedagogical Roles

The shift from lecture-centric teaching to an ID-driven, performance-focused model necessitates significant faculty retraining. The instructor’s role transforms from mere content provider to **learning architect and facilitator**. Implementing Merrill’s principles effectively requires faculty adeptness in designing effective demonstration artifacts (e.g., concise procedural videos) and providing targeted, constructive feedback on complex performance submissions—skills distinct from essay grading. Faculty development must emphasize **rubric design for performance assessment**

and moderation techniques for constructivist forums (Harris & Rea, ٢٠١٦).

Integrating Advanced Technologies for Future Practicality

Acknowledging current constraints, future optimization lies in technologies like **Augmented Reality (AR)**. Research suggests AR could allow students to use mobile devices to overlay digital information (e.g., nutrient deficiency identification) onto real plants in their local environment, effectively transforming their immediate surroundings into an interactive laboratory (Liu et al., ٢٠٢١). This represents the ideal fusion of context specificity and practical application, driven by situated cognition theories.

Table ٢: Challenges and Solutions for ID in Online Agriculture

Challenge	Solution
Practical Skill Deficit	Integrate virtual labs/simulations focused on Merrill’s Application Principle.
Bandwidth Constraints	• Implement Robust Design via low-bandwidth alternatives (text-scenarios, low-res videos).
Lack of Contextualization	• Anchor learning using local data sets and case studies from Markazi Province.
Assessment Misalignment	• Employ performance-based assessments with detailed rubrics for practical skills (e.g., video submissions).
Faculty Role Shift	Mandatory faculty workshops on rubric design, performance feedback, and online moderation techniques.

Conceptual Model Illustration: The relationship—ADDIE framing the structure, Merrill driving performance, and Constructivism

enabling collaborative knowledge building—is conceptually illustrated in **Figure ٢**.

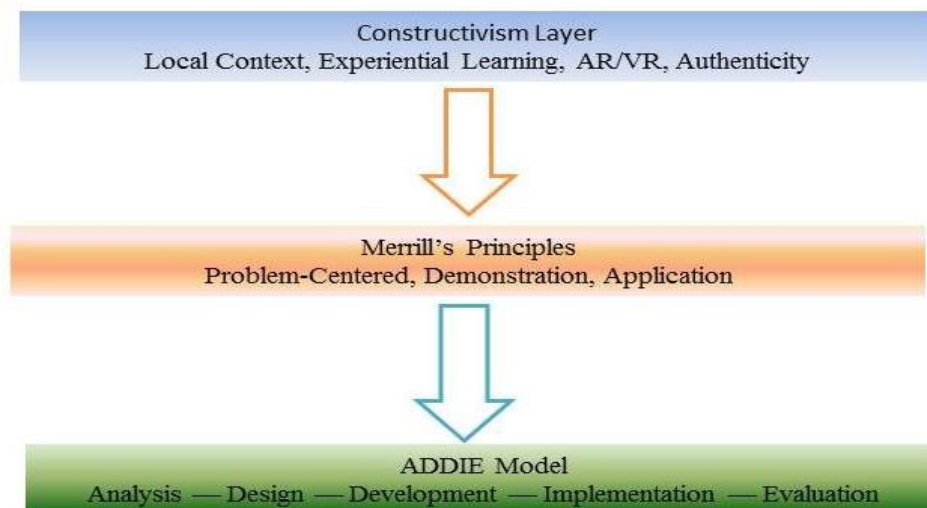


Figure ٢: *Conceptual Model of ADDIE, Merrill's Principles, and Constructivism*

Conclusion and Recommendations

This systematic review confirms that the transition of agricultural education to online formats, necessitated by modern demands and institutions like Payame Noor University (PNU), requires the deliberate application of rigorous instructional design principles. Effective online agriculture education must be inherently performative, deeply contextualized, and highly interactive. The synergy between the systematic planning of **ADDIE**, the performance focus of **Merrill's Principles** (particularly demonstration and application), and the interactive knowledge building of **Constructivism** offers a potent pedagogical framework for PNU's agricultural programs. Generic online course templates are insufficient; success depends on localizing the design process to address the systemic **"Practical Deficit."**

Recommendations for PNU (Markazi Province)

Future efforts at PNU must prioritize the following actionable strategies derived from the evidence:

Iterative ADDIE Cycles (Structural Implementation): Establish formal processes for rapid feedback loops from the Evaluation

phase directly into course redesign, ensuring these iterative adjustments are informed by local student performance metrics within Markazi Province.

Merrill's Mandate (Performance Focus):

Ensure that every significant learning objective requiring a skill is followed by a structured, assessed **Application** activity, even if mediated through high-fidelity simulations or locally relevant case studies. Faculty development must emphasize designing effective demonstration artifacts and performance-based rubrics.

Technology Scaffolding (Contextual Investment): While developing content that scales effectively across current bandwidth limitations (e.g., text-based scenarios), strategically invest in high-impact tools like **Augmented Reality (AR)** for modules where practical immersion—such as identifying deficiencies on a real plant—is irreplaceable.

By adhering to these integrated ID frameworks and incorporating context-sensitive technologies, PNU can significantly enhance the competence, engagement, and eventual success of its agriculture students, contributing meaningfully to the region's agricultural development.

Limitations

This review is subject to several limitations that frame the generalizability and depth of the findings. First, the dominance of literature originating from **Western educational contexts** means that the nuances of localized socio-economic and infrastructural barriers specific to Iranian higher education may not be fully captured. Second, the study's focus on **PNU and Markazi Province** inherently limits the direct generalizability of these specific findings to all other regional universities or disciplines. Furthermore, while the synthesis identified a strong correlation between bandwidth and simulation failure, a formal **meta-analysis** quantifying the exact performance gain attributable solely to strict adherence to Merrill's principles versus general digital instruction was beyond the scope of this systematic review structure.

Future Research

Future research should focus on empirically evaluating the effectiveness of the proposed integrated instructional design framework within PNU's actual online agricultural courses. This must include comparative studies assessing the impact of **virtual labs, simulations, and contextualized case studies** anchored to Markazi Province data on measurable student learning outcomes. Further exploration is also needed to investigate the potential of emerging technologies, such as **AR and VR**, for enhancing practical skill development in a low-resource digital environment.

Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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