Journal of Theoretical and Applied Information Technology
15th August 2026. Vol.104. No.15

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

# THE VISTA TRAINING MODEL: A MISSION-BASED VIRTUAL WORLD APPROACH TO 3D SCENE CREATION

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**ABSTRACT**

This study developed and evaluated the VISTA Training Model, a mission-based virtual-world approach to 3D scene creation. A three-phase research and development process covered model design, development of mission-based activities and a learning environment implemented in Spatial, and implementation with learners. The five stages were Virtual Orientation, Identify the Mission, Survey and Strategize, Three-dimensional Creation, and Assess, Adjust and Apply. Five experts evaluated the model, activity plans, and virtual environment. The implementation used a one-group pretest-posttest pre-experimental design with 15 graduate students. The principal investigator and the second author independently rated participants' pretest performance, posttest performance, and completed projects using analytic rubrics. Expert ratings were at the highest interpretation level for the model (M = 4.71), activity plans (M = 4.75), and virtual environment (M = 4.68). The overall competency score was higher at posttest (M = 4.45, SD = 0.21) than at pretest (M = 2.85, SD = 0.49), t(14) = 13.48, p < .001, Cohen's $d_z$ = 3.48. Inter-rater ICCs ranged from .82 to .91. Completed-project quality (M = 4.53, SD = 0.28) was strongly associated with posttest competency, r = .78, 95% CI [.45, .92], p < .001. Learner satisfaction was rated at the highest level (M = 4.80, SD = 0.40). Within this one-group sample, posttest competency scores were higher, completed projects were rated highly, and participants reported high satisfaction. These findings provide preliminary evidence of the model's feasibility as a mission-based virtual-world approach to 3D scene creation; they do not establish causal effectiveness.

**Keywords:** *3D scene creation, immersive learning technology, mission-based learning, virtual world learning environment, 3D content production*

## 1. INTRODUCTION

The rapid development of immersive technologies such as virtual reality (VR), augmented reality (AR), mixed reality (MR), and virtual world environments has influenced educational practices and professional training across multiple disciplines [1]-[4]. Virtual world environments provide interactive three-dimensional (3D) spaces in which learners can explore, collaborate, manipulate digital objects, and produce content through authentic and experiential activities [2]-[4]. The use of immersive technologies in art and design education, landscape architecture, 3D modeling, and spatial-reasoning instruction has drawn attention to the competencies needed to design and create high-quality 3D environments [5]-[8]. Hence, the acquisition of 3D scene creation skills is an important educational objective for higher education institutions preparing graduates for the digital workforce.

Creating a complete 3D scene requires more than technical command of modeling software. Learners must integrate spatial visualization, scene composition, object placement, materials and textures, lighting, environmental storytelling, and aesthetic judgment [9]-[12]. These competencies develop through sustained practice, iterative refinement, and application of design principles in meaningful contexts [7], [9]-[12]. Yet instruction for novices often prioritizes discrete software operations over the complete design and production process. Learners may therefore produce individual 3D objects without being able to assemble them into coherent, functional, and visually balanced scenes.

Virtual world environments can support this type of learning by providing immersive, collaborative, and context-rich spaces [13]-[17]. Learners can interact with digital objects, present work in progress, obtain visual feedback, compare alternative designs, and discuss production

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

decisions. Systematic reviews nevertheless report heterogeneous outcomes and emphasize that learning depends on pedagogical design, learner characteristics, and implementation conditions [2]-[4], [14]-[17]. Much of the existing work still centers on technology adoption, usability, presence, or engagement rather than specifying a structured instructional sequence for developing complete 3D scene creation competencies.

Mission-Based Learning, as operationalized in this study, organizes learning around authentic missions that require problem identification, planning, decision-making, collaboration, solution development, and evaluation. This structure is aligned with challenge-based, project-based, and problem-based learning, in which learners address meaningful problems and produce contextually relevant solutions or artifacts [18]-[26]. These approaches can support engagement, critical thinking, and problem solving, but their outcomes vary with task design, scaffolding, assessment, duration, and context. Their integration with immersive virtual-world environments for end-to-end 3D scene production remains limited, particularly when instruction must guide learners from orientation and mission analysis through planning, creation, feedback, revision, and transfer.

The research problem is therefore not simply a lack of immersive technology. Existing 3D instruction often emphasizes software operations or isolated modeling tasks, whereas virtual-world studies frequently report interaction or usability outcomes without documenting the complete production and assessment process [7]-[17], [37]-[47]. Few studies connect authentic mission specifications, scaffolded production, a collaborative virtual workspace, digital artifact exchange, formative feedback, revision, and performance-based assessment within one reproducible workflow. This separation leaves educators with limited guidance for organizing complete 3D scene creation training in an accessible virtual environment.

To address this problem, the VISTA Training Model was designed as a mission-based virtual-world approach with five interconnected stages: Virtual Orientation, Identify the Mission, Survey and Strategize, Three-dimensional Creation, and Assess, Adjust and Apply. The model maps these stages to five functional areas distributed across seven physical zones in a web-accessible virtual environment and connects Blender-based scene production with communication, presentation, review, and reflection in Spatial. The virtual world is thus used as an instructional and collaborative workspace rather than solely as a presentation technology.

This study makes four contributions. First, it proposes an integrated conceptual model for mission-based 3D scene creation. Second, it operationalizes the model through five functional areas distributed across seven physical zones and a documented Blender-to-Spatial content workflow. Third, it combines process-oriented competency assessment with final-product evaluation. Fourth, it reports within-group pretest-posttest evidence and independent ratings by two assessors. Together, these contributions provide a documented link among mission analysis, professional 3D production, virtual-world interaction, feedback, revision, and performance assessment.

Accordingly, the study aimed to (1) develop the VISTA Training Model for the complete 3D scene creation workflow; (2) develop and validate the mission-based activity plans and supporting Virtual World Learning Environment; and (3) examine within-group pretest-posttest changes, completed-project quality, the association between posttest competency and project quality, and learner satisfaction. The study is significant because it translates related pedagogical principles into an implementable technical and instructional workflow while keeping interpretation consistent with the limits of a one-group design.

## 2. LITERATURE REVIEW

### 2.1 Virtual World Environments in Education

Virtual world environments are immersive learning platforms that allow learners to interact with three-dimensional digital spaces in authentic and collaborative contexts. Unlike most conventional online learning environments, virtual worlds can provide real-time interaction, spatial exploration, object manipulation, and collaborative experiences resembling real or professional situations. These features are consistent with formative feedback, experiential learning, situated cognition, authentic learning, and holistic immersive-learning frameworks [27]-[33].

Research has reported positive but variable outcomes for motivation, participation, collaboration, spatial understanding, creativity, and practical skill development across engineering, architecture, medical education, digital media, and teacher education [2]-[4], [13]-[17]. The principal strength of virtual-world approaches is their capacity to combine spatial interaction with shared activity. Their recurring limitations include uneven usability, equipment and network constraints,

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

variation in learner readiness, and insufficient specification of the pedagogy that organizes the technology. Consequently, fewer studies explain how virtual spaces can support a complete creative-production workflow such as 3D scene creation.

Recent analyses of the educational metaverse similarly emphasize that persistent and interactive virtual spaces require explicit pedagogical roles, usability planning, ethical safeguards, and institutional support rather than technology adoption alone [34]-[36]. These studies clarify adoption conditions but provide limited guidance on how mission analysis, professional authoring tools, artifact exchange, feedback, and performance assessment should be connected during training.

### 2.2 Mission-Based Learning

In the present study, mission-based learning is defined as a form of instructional organization that involves authentic missions in which students identify problems, analyze situations, formulate strategies, implement solutions, and assess results. This mission-oriented structure shares basic characteristics with challenge-based, project-based and problem-based learning [18]-[26]. Learning missions are designed to simulate real-world challenges, prompting learners to apply knowledge as part of cultivating higher-order thinking, collaboration, and self-directed learning.

Studies of these related pedagogies report benefits for motivation, engagement, critical thinking, creativity, problem solving, teamwork, and real-world skill development; however, outcomes depend on scaffolding, assessment, task design, duration, and learner context [18]-[26]. Their strength lies in organizing learning around meaningful problems and products. A limitation for the present context is that the literature does not specify how a mission sequence should be embedded in a persistent virtual workspace and linked to a professional 3D production workflow. This integration remains underexplored.

### 2.3 3D Scene Creation Competencies

The ability to construct a 3D scene is a multidimensional competency that combines technical knowledge with artistic, spatial, and evaluative judgment [7]-[12]. Learners must integrate object modeling, spatial composition, object placement, material and texture creation, lighting, atmosphere, optimization, and visual storytelling to produce a coherent virtual environment.

Research on 3D modeling, spatial ability, and digital creativity, together with evidence on formative feedback and peer assessment, emphasizes continuous practice, authentic design contexts, iterative refinement, and constructive feedback [7]-[12], [27], [28], [37]. Contextualized computer-graphics curricula and Blender-centered courses demonstrate the value of meaningful projects and assessed student artifacts [38], [39]. Their strength is direct engagement with production tasks; however, many approaches remain centered on software operation or individual modeling techniques. They therefore provide limited guidance for integrating the full sequence of scene planning, composition, materials, lighting, testing, revision, and presentation.

### 2.4 Training Models and Authentic Performance Assessment

Training models organize learning into structured stages through which learners progressively acquire knowledge and practical skills. Effective models commonly include learner preparation, guided practice, authentic tasks, feedback, reflection, and performance assessment to support transfer [27]-[33], [37], [40]-[47].

Recent educational research has examined competency-oriented learning, experiential learning, authentic assessment, learner-centered design, peer feedback, and validated analytic rubrics [27]-[33], [37], [40]-[47]. These approaches offer transparent criteria and opportunities for feedback and reflection. However, models for digital skills, immersive learning, and creative production often treat the learning environment, production process, and assessment system as separate components. Few integrate a virtual world, mission-oriented tasks, scaffolded production, and authentic performance assessment into a single framework for complete 3D scene creation.

### 2.5 Research Gap and Contributions of the VISTA Training Model

Taken together, the literature identifies four relevant but only partially connected research streams: immersive and virtual-world learning [13]-[17], [29]-[36]; mission-oriented challenge, project, and problem structures [18]-[26]; 3D modeling and digital creativity [7]-[12], [38], [39]; and authentic performance assessment [37], [40]-[47]. Each stream contributes important design principles, but the reviewed work seldom combines them in a comprehensive model for 3D scene creation.

A persistent gap is the separation between technological implementation and instructional process design. Virtual-world studies may describe interaction, usability, or engagement without specifying how learners progress from mission requirements to production plans, 3D authoring, artifact exchange, feedback, and revision. Conversely, 3D modeling studies may emphasize software or spatial outcomes without embedding production in a collaborative virtual-world workflow or linking process evidence to final-product assessment.

The VISTA Training Model addresses this gap by aligning pedagogical stages, functional virtual spaces, professional production tools, and assessment evidence. Learners interpret missions, plan production, create scenes in Blender, present and review artifacts in Spatial, revise their work, and submit evidence for independent performance assessment. The contribution is therefore operational rather than a claim that any single component is novel in isolation.

Table 1 synthesizes the strengths of the four research streams and specifies the gap addressed by the integrated VISTA workflow.

*Table 1: Synthesis of Related Research and the Gap Addressed by VISTA*

| Research stream | Main contribution | Gap addressed by VISTA |
|---|---|---|
| Immersive and virtual-world learning [2]-[4], [13]-[17] | Interaction, presence, collaboration, and spatial experience | Adds a complete mission-to-production workflow and structured assessment |
| Challenge-, project-, and problem-based learning [18]-[26] | Authentic tasks, learner agency, and problem solving | Implements mission processes inside a persistent virtual workspace |
| 3D modeling and digital creativity [7]-[12] | Technical, spatial, and creative skill development | Extends beyond isolated modeling to complete scene production |
| Authentic and performance assessment [37], [40]-[47] | Rubrics, contextual tasks, transparent criteria, and reflection | Combines pretest-posttest competency evidence with final-project quality |
| VISTA Training Model | Integrated mission, virtual-world, production, feedback, and assessment approach | Provides an applied IT workflow linking Spatial, Blender, and independent rating |

## 3. RESEARCH OBJECTIVES

3.1 To develop the VISTA Training Model as a mission-based virtual world approach for supporting the complete 3D scene creation workflow.

3.2 To develop and validate mission-based training activity plans and a Virtual World Learning Environment that integrates interaction in Spatial with Blender-based 3D production.

3.3 To examine pretest-posttest changes in learners' 3D scene creation competencies, the quality of completed 3D scene projects, the relationship between posttest competencies and project quality, and learners' satisfaction with the training experience.

## 4. RESEARCH METHODOLOGY

The study used a three-phase Research and Development (R&D) methodology aligned with the three research objectives. Phase 1 developed and expert-reviewed the conceptual and instructional model. Phase 2 developed and technically verified the mission-based activity plans and supporting virtual world environment. Phase 3 implemented the model through a one-group pretest-posttest pre-experimental design and examined within-group competency change, completed-project quality, inter-rater reliability, the association between posttest competency and project quality, and learner satisfaction. The Phase 3 design was suitable for describing change within the participating group but did not support causal attribution.

### 4.1 Phase 1: Development of the VISTA Training Model

The first phase developed the conceptual and instructional framework of the VISTA Training Model. The analysis addressed learner characteristics, training needs, the complete 3D scene production process, and competency requirements. The conceptual framework synthesized Mission-Based Learning, Virtual World Learning Environments, Experiential and Constructivist Learning, and 3D Scene Creation.

The predefined learning outcomes comprised five competency dimensions: 3D Modeling, 3D Scene Composition, Material and Texturing, Lighting and Atmosphere, and Testing and Improvement.

The final model comprised five sequential and iterative stages: Virtual Orientation, Identify the Mission, Survey and Strategize, Three-dimensional Creation, and Assess, Adjust and Apply. Five experts with expertise in educational technology, immersive learning, instructional design, or digital media production evaluated the conceptual framework, learning process, and outcomes using a five-point rating scale. Their item-level ratings and recommendations were used to revise the model before implementation.

### 4.2 Phase 2: Development of Mission-Based Activities and the Virtual World

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The second phase developed two mutually aligned components: the mission-based activity plans and the technical virtual world environment used to implement the model.

#### 4.2.1 Mission-based training activity plans

The mission-based training activity plans were developed around the five VISTA stages. Each plan specified learning objectives, mission scenarios, tasks, procedures, digital resources, assessment criteria, expected evidence, and opportunities for feedback and revision. Parallel pretest and posttest performance tasks were designed with different mission contexts and assets but equivalent competency requirements to reduce direct task repetition while preserving comparability.

#### 4.2.2 Virtual world environment design and technical implementation

The Virtual World Learning Environment was created in Spatial, a cloud-based platform that can be accessed through a web browser on a desktop or laptop. Spatial was chosen because it provided avatar-based interaction, real-time communication, collaborative exploration, screen sharing and presentation of 2D and 3D content without the requirement for specialized VR equipment. Learners created scenes using Blender and exported artifacts in formats supported by Spatial for uploading to present progress, peer review, instructor feedback, revision, and final assessment. The environment consisted of seven physical zones organized into five functional areas that mapped onto the VISTA stages: Virtual Orientation; Mission Briefing and Analysis; Resource Exploration and Strategic Planning; 3D Creation and Progress Presentation; and Assessment, Feedback and Reflection. Development was based on the System Development Life Cycle: requirements analysis, information and interaction design, implementation, content integration, functional and usability verification, revision and deployment. Table 2 summarizes the technical configuration.

*Table 2: Technical Configuration of the VISTA Virtual World Environment*

| Component | Implementation |
|---|---|
| Virtual world platform | Spatial cloud-based virtual environment |
| 3D authoring tool | Blender |
| Access method | Desktop/laptop web browser; no dedicated VR headset required |
| Interaction functions | Avatar movement, synchronous communication, collaboration, and screen sharing |
| Content workflow | Blender creation, export, Spatial upload, presentation, feedback, and revision |
| Functional learning areas | Seven physical zones grouped into five functional areas aligned with the VISTA stages |
| Assessment support | Pretest/posttest evidence, project presentation, analytic rubrics, and independent ratings |

The VISTA virtual world approach integrates instructional activities, 3D production tools, and collaborative virtual spaces into a connected workflow. Figure 1 illustrates the technical architecture and information flow linking learners, Blender-based content creation, the Spatial platform, feedback processes, and performance assessment.

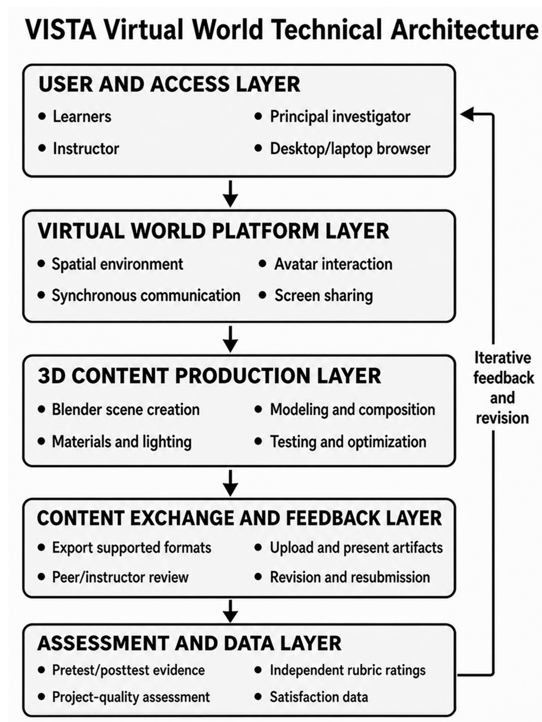


*Figure 1: Technical architecture and information flow of the VISTA virtual world approach*

Five experts evaluated the quality and suitability of the activity plans and virtual world environment using five-point rating scales. The environment was also functionally verified against the required access, communication, content-presentation, artifact-exchange, feedback, and assessment functions before deployment.

### 4.3 Phase 3: Implementation and Evaluation of the VISTA Training Model

The third phase implemented the VISTA Training Model in a real training setting. The evaluation examined pretest-posttest changes in 3D scene creation competencies, the quality of

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completed 3D scene projects, the relationship between posttest competencies and project quality, and learner satisfaction. The phase also examined the reliability of the two independent author-raters.

#### 4.3.1 Participants

The population comprised graduate students enrolled in the Digital Technology in Technical Education program at King Mongkut's University of Technology North Bangkok during the second semester of the 2025 academic year. Participants were recruited through non-probability volunteer sampling. Fifteen graduate students who wished to further develop their 3D scene creation knowledge and skills agreed to participate. Eligibility criteria were basic digital technology knowledge, introductory familiarity with 3D modeling, and the ability to attend and complete all scheduled activities. Because the sample came from one academic program and participation was voluntary, it was not intended to represent a broader population.

#### 4.3.2 Research design

The implementation phase employed a one-group pretest-posttest pre-experimental design. Before receiving any orientation, instructional support, feedback, or access to the training activities, participants completed the pretest mission, "Digital Creative Workspace," which required the creation of a small interior 3D scene containing specified furniture, digital equipment, materials, lighting, and camera composition. After completing the fifth training session, participants completed the parallel posttest mission, "Virtual Innovation Studio," which had comparable production requirements but used a different context and assets. Both tasks followed the same assessment blueprint and used the same time allocation, software, equipment, written instructions, submission procedures, and 25-criterion competency rubric. No instructional assistance or formative feedback was provided during either assessment. Task equivalence was reviewed by experts in terms of competency coverage, required components, technical complexity, expected completion time, and alignment with the five competency dimensions. The use of parallel tasks reduced direct task repetition but did not remove the limitations of the one-group design; observed pretest-posttest differences cannot be attributed exclusively to the training model.

#### 4.3.3 Implementation outcomes

The implementation phase examined:

a) pretest-posttest changes in learners' 3D scene creation competencies;

b) the quality of completed 3D scene projects and its relationship with posttest competency; and

c) learners' satisfaction with the VISTA Training Model and virtual world environment.

#### 4.3.4 Research instruments

The research instruments consisted of:

a) the VISTA Training Model;

b) the mission-based training activity plans;

c) the virtual world learning environment;

d) the Pretest-Posttest 3D Scene Creation Competency Rubric;

e) the Completed 3D Scene Project Assessment Rubric;

f) the Learner Satisfaction Questionnaire.

Five experts assessed the content validity of the research instruments using the Item-Objective Congruence (IOC) technique; IOC values ranged from 0.80 to 1.00. The satisfaction questionnaire was pilot tested with a comparable group and yielded a Cronbach's alpha coefficient of .91.

The competency rubric contained 25 criteria across five dimensions and used five performance levels with explicit descriptors. The same competency framework was applied to the parallel pretest and posttest tasks. The project-quality rubric evaluated modeling accuracy, scene composition, materials and texturing, lighting and atmosphere, technical optimization and functionality, creativity and visual aesthetics, and alignment with the assigned mission.

#### 4.3.5 Independent rater protocol

The principal investigator and second author assessed the coded pretest, posttest, and completed projects independently. Both used the same rubric descriptors and separate scoring files, and neither viewed the other rater's scores before recording an initial rating. The mean of the two ratings was used for group-level analyses.

Inter-rater reliability was estimated separately for pretest competency, posttest competency, and completed-project quality using a two-way mixed-effects, single-measure intraclass correlation coefficient. Absolute agreement was the intended definition because the same two raters assessed all participants and agreement in individual-rater scores was of interest [48].

#### 4.3.6 Implementation procedure

The implementation protocol comprised five six-hour sessions conducted once a week for five consecutive weeks, for a total of 30 scheduled hours. The sequence included the pretest, orientation, mission-based training activities, formative feedback and revision, the posttest, project submission, independent scoring, and satisfaction assessment, as detailed below.

a) administering the parallel baseline performance task before orientation or instructional support;

b) introducing the VISTA Training Model, training procedures, assessment criteria, and virtual world environment;

c) conducting virtual orientation and familiarization activities;

d) presenting mission scenarios, objectives, requirements, constraints, and expected outcomes;

e) supporting resource exploration, production planning, and 3D scene creation;

f) providing formative feedback and opportunities for peer and instructor review;

g) allowing participants to test, revise, optimize, and improve their scenes;

h) administering the parallel posttest task and collecting the completed 3D scene projects;

i) conducting two independent rubric assessments and administering the learner satisfaction questionnaire.

#### 4.3.7 Data collection

Data were collected from five sources:

a) expert evaluations of the VISTA Training Model;

b) expert evaluations and functional verification of the activity plans and virtual world environment;

c) independently rated pretest and posttest competency assessments;

d) independently rated completed-project assessments; and

e) learners' responses to the satisfaction questionnaire.

## 5. DATA ANALYSIS

Qualitative information from document analysis, expert recommendations, and functional verification records was examined through content analysis and used to refine the model, activity plans, and virtual world environment.

Quantitative analyses included descriptive statistics, inter-rater reliability, an overall paired-samples comparison, and correlation analyses. Means and standard deviations summarized expert ratings, competency scores, project quality, and satisfaction. Mean scores were interpreted as follows: 4.51-5.00 = Highest, 3.51-4.50 = High, 2.51-3.50 = Moderate, 1.51-2.50 = Low, and 1.00-1.50 = Lowest.

Inter-rater reliability was evaluated using intraclass correlation coefficients (ICCs) with 95% confidence intervals. ICC values below .50 were interpreted as poor, .50–.75 as moderate, .75–.90 as good, and above .90 as excellent [48].

A paired-samples t-test compared the overall pretest and posttest competency scores. Cohen's $d_z$ and the 95% confidence interval of the mean difference were calculated to describe the magnitude and precision of the observed change [49]. Dimension-level comparisons were exploratory and descriptive.

Pearson's product-moment correlation coefficient, together with its 95% confidence interval, was used to examine the association between posttest competency and completed-project quality. Spearman's rank-order correlation was calculated as a sensitivity analysis because of the small sample. All tests were two-tailed with an alpha level of .05, and correlation findings were interpreted as associations rather than causal effects.

## 6. RESULTS

### 6.1 Development of the VISTA Training Model

The VISTA Training Model was developed by synthesizing concepts from Mission-Based Learning, Virtual World Learning Environments, Experiential and Constructivist Learning, and 3D Scene Creation. The resulting model comprises a conceptual framework, a five-stage learning process, and five competency outcomes.

#### 6.1.1 Conceptual framework

The conceptual framework integrates four key instructional foundations that collectively support the development of learners' 3D scene creation skills:

a) *Mission-Based Learning:* Learning is organized through authentic missions that encourage learners to analyze problems, make decisions, collaborate with peers, and accomplish meaningful tasks.

b) *Virtual World Learning Environment:* An immersive virtual environment enables learners to interact with digital objects, communicate with peers, and perform practical activities within realistic three-dimensional spaces.

c) *Experiential and Constructivist Learning:* Learning experiences emphasize active participation, knowledge construction, reflection, and continuous improvement through authentic practice.

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d) *3D Scene Creation:* Learners integrate technical knowledge with creativity to design complete virtual scenes using professional 3D production workflows.

The integration of these four components establishes the conceptual foundation of the VISTA Training Model, as illustrated in Figure 2.

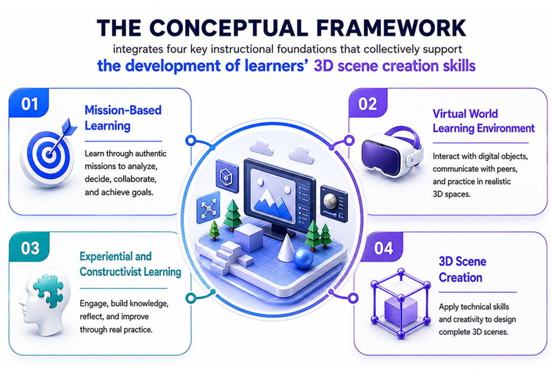


*Figure 2: Conceptual framework of the VISTA Training Model*

### 6.1.2 Learning process

The learning process of the VISTA Training Model consists of five sequential stages designed to support mission-based learning in a virtual world environment.

a) *Virtual Orientation (V):* Learners are introduced to the virtual environment, learning tools, communication features, training procedures, and assessment criteria.

b) *Identify the Mission (I):* Learners analyze the mission scenario, objectives, expected outcomes, requirements, constraints, and evaluation criteria.

c) *Survey and Strategize (S):* Learners explore relevant resources, analyze design requirements, plan the scene concept, select appropriate assets, and determine the production strategy.

d) *Three-dimensional Creation (T):* Learners create complete 3D scenes by integrating modeling, scene composition, materials and textures, lighting, and atmosphere through practical mission-based activities.

e) *Assess, Adjust and Apply (A):* Learners evaluate their work, receive feedback, revise and improve the scene, reflect on the learning process, and apply the acquired skills to new situations.

The five stages operate as an iterative cycle, enabling learners to revisit earlier stages when further planning, revision, or improvement is required. Figure 3 illustrates this iterative cycle.


*Figure 3: Five-stage learning process of the VISTA Training Model*

The learning process combines authentic missions, virtual-world interaction, collaborative problem solving, and formative assessment. The stages provide a structured route from mission interpretation to production, review, and revision in a professional 3D content workflow.

### 6.1.3 Learning outcomes

The learning outcomes specify the 3D scene creation competencies assessed during the mission-based activities. The competency framework consists of five dimensions.

a) *3D Modeling Skills:* The ability to create accurate and optimized three-dimensional models that meet functional and aesthetic requirements.

b) *3D Scene Composition Skills:* The ability to organize 3D objects, environmental elements, and spatial layouts into coherent and visually balanced scenes.

c) *Material and Texturing Skills:* The ability to apply appropriate materials, textures, and surface properties to support realism and visual quality.

d) *Lighting and Atmosphere Skills:* The ability to design lighting, shadows, and environmental effects that effectively communicate mood, depth, and realism.

e) *Testing and Improvement Skills:* The ability to evaluate completed 3D scenes, identify design and technical issues, revise the work based on feedback, and continuously improve the final product.

Together, the five dimensions represent the technical, creative, and reflective competencies assessed in the study. Figure 4 summarizes the five intended competency outcomes.

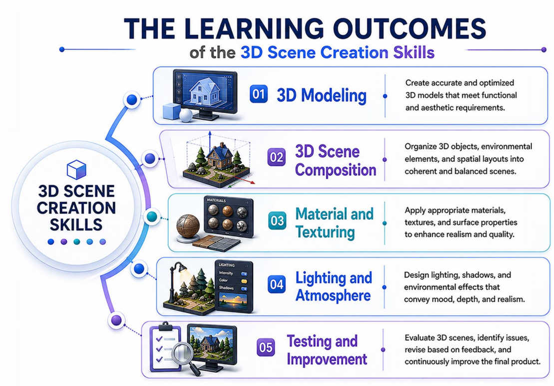


*Figure 4: Intended 3D scene creation competency outcomes*

The conceptual framework, learning process, and learning outcomes form the complete structure of the VISTA Training Model. The three components link mission interpretation and production planning with scene creation, evaluation, and revision. To examine the appropriateness and alignment of the developed model, five experts in educational technology, immersive learning, instructional design, and digital media production evaluated its conceptual framework, learning process, and learning outcomes using a five-point rating scale. The evaluation results are presented in Table 3.

*Table 3: Expert Evaluation of the VISTA Training Model*

| Components of VISTA training model | Expert evaluation | | |
|---|---|---|---|
| | *Mean* | *SD* | Level |
| **1. Conceptual Framework** | | | |
| 1.1 Mission-Based Learning | 4.60 | 0.55 | Highest |
| 1.2 Virtual World Learning Environment | 4.80 | 0.45 | Highest |
| 1.3 Experiential and Constructivist Learning | 4.80 | 0.45 | Highest |
| 1.4 3D Scene Creation | 4.60 | 0.55 | Highest |
| **Component Mean** | **4.70** | **0.39** | **Highest** |
| **2. Learning Process** | | | |
| 2.1 Virtual Orientation | 4.80 | 0.45 | Highest |
| 2.2 Identify the Mission | 4.60 | 0.55 | Highest |
| 2.3 Survey and Strategize | 4.80 | 0.45 | Highest |
| 2.4 Three-dimensional Creation | 4.60 | 0.55 | Highest |
| 2.5 Assess, Adjust and Apply | 4.80 | 0.45 | Highest |
| **Component Mean** | **4.72** | **0.27** | **Highest** |
| **3. Learning Outcomes** | | | |
| 3.1 3D Modeling | **4.80** | **0.45** | Highest |
| 3.2 3D Scene Composition | **4.80** | **0.45** | Highest |
| 3.3 Material and Texturing | **4.60** | **0.55** | Highest |
| 3.4 Lighting and Atmosphere | **4.60** | **0.55** | Highest |
| 3.5 Testing and Improvement | **4.80** | **0.45** | Highest |
| **Component Mean** | **4.72** | **0.27** | **Highest** |
| **Overall Mean** | **4.71** | **0.31** | **Highest** |

Table 3 shows that experts rated the VISTA Training Model at the highest interpretation level overall (M = 4.71, SD = 0.31). The Learning Process and Learning Outcomes had the same component mean (M = 4.72, SD = 0.27), while the Conceptual Framework received M = 4.70 (SD = 0.39). These ratings indicate the experts' perceived appropriateness and alignment of the model components; they do not constitute evidence of learner effectiveness. Figure 5 presents the complete structure of the VISTA Training Model.

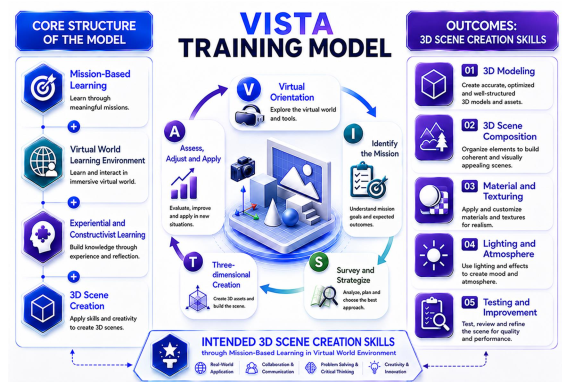


*Figure 5: Complete structure of the VISTA Training Model*

The experts recommended more explicit implementation guidance for each training stage, closer alignment between missions and learning outcomes, additional examples of authentic 3D scene tasks, and clearer assessment and feedback procedures. The model and supporting materials were revised in response to these recommendations.

After revision, the model retained its three-component structure and five-stage iterative cycle. The expert ratings indicated high perceived appropriateness and alignment among the conceptual framework, learning process, and intended outcomes.

## 6.2 Development and Technical Validation of the Supporting Environment

The mission-based learning activities were developed to support the implementation of the VISTA Training Model. The development process is described in the following sections.

### 6.2.1 Mission-based training activity plans

The mission-based activity plans were designed in accordance with the five VISTA stages. Each plan specified learning objectives, mission scenarios, learning activities, assessment methods, and expected outcomes. Expert ratings placed the

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activity plans at the highest interpretation level for appropriateness.

*Table 4: Expert Evaluation of the Mission-Based Training Activity Plans*

| Evaluation Items | Expert evaluation | | |
|---|---|---|---|
| | ***Mean*** | ***SD*** | **Level** |
| 1. The training activity plans are consistent with the VISTA Training Model. | 4.80 | 0.45 | Highest |
| 2. The learning objectives are appropriate and clearly defined. | 4.80 | 0.45 | Highest |
| 3. The mission scenarios promote authentic learning experiences. | 4.60 | 0.55 | Highest |
| 4. The learning tasks encourage collaboration, problem-solving, and creativity. | 4.80 | 0.45 | Highest |
| 5. The instructional procedures systematically follow the five stages of the VISTA Training Model. | 4.80 | 0.45 | Highest |
| 6. The learning resources adequately support mission completion. | 4.60 | 0.55 | Highest |
| 7. The assessment methods effectively evaluate learners' 3D scene creation skills. | 4.80 | 0.45 | Highest |
| 8. The expected learning outcomes are aligned with the objectives of the training model. | 4.80 | 0.45 | Highest |
| **Overall Mean** | **4.75** | **0.28** | **Highest** |

Table 4 indicates that the mission-based activity plans were evaluated at the highest level overall (M = 4.75, SD = 0.28). The expert ratings indicated alignment among the VISTA stages, mission scenarios, learning tasks, assessment criteria, and intended competencies.

### 6.2.2 Virtual world learning environment

The virtual world learning environment was developed through the System Development Life Cycle (SDLC). It incorporated functional areas for orientation, mission briefing, collaboration, 3D scene presentation, feedback, and reflection. Expert ratings placed the environment at the highest interpretation level for appropriateness.

*Table 5: Expert Evaluation of the Virtual World Learning Environment*

| Evaluation Items | Expert evaluation | | |
|---|---|---|---|
| | ***Mean*** | ***SD*** | **Level** |
| 1. The virtual learning environment is appropriately designed to support the VISTA Training Model. | 4.80 | 0.45 | Highest |
| 2. The interface design is clear, user-friendly, and easy to navigate. | 4.40 | 0.55 | High |
| 3. The mission scenarios provide authentic and meaningful learning experiences. | 4.80 | 0.45 | Highest |
| 4. The virtual learning spaces effectively support communication and collaboration among learners. | 4.80 | 0.45 | Highest |
| 5. The environment effectively supports 3D scene creation through interactive learning activities. | 4.60 | 0.55 | Highest |
| 6. The learning resources and digital objects are appropriate for completing mission-based activities. | 4.60 | 0.55 | Highest |
| 7. The assessment and feedback mechanisms effectively support learners' continuous improvement. | 4.80 | 0.45 | Highest |
| 8. The overall virtual world learning environment is appropriate for supporting the development of learners' 3D scene creation skills. | 4.60 | 0.55 | Highest |
| **Overall Mean** | **4.68** | **0.33** | **Highest** |

Table 5 indicates that the virtual world learning environment was evaluated at the highest level overall (M = 4.68, SD = 0.33). The highest ratings were given to model alignment, mission authenticity, collaborative support, and feedback mechanisms. Interface design received the lowest expert mean (M = 4.40, SD = 0.55), identifying usability as a priority for orientation and revision.

### 6.2.3 Functional verification

Functional verification examined whether the implemented environment supported the information and interaction requirements defined during Phase 2. The final revised version supported the core functions summarized in Table 6.

*Table 6: Functional Verification of the Virtual World Environment*

| Function | Verification criterion | Final status |
|---|---|---|
| User access and navigation | Browser access and movement among the five functional areas | Operational after revision |
| Avatar communication | Synchronous interaction and collaborative participation | Operational after revision |
| Screen and content presentation | Presentation of 2D resources and Blender work in progress | Operational after revision |

| Function | Verification criterion | Final status |
|---|---|---|
| 3D artifact workflow | Export, upload, display, and review of Spatial-supported files | Operational after revision |
| Feedback and revision | Peer/instructor review and resubmission of improved artifacts | Operational after revision |
| Assessment support | Display and review of coded evidence using analytic rubrics | Operational after revision |

The verification focused on functional adequacy rather than server benchmarking or comparative platform performance. Device performance, network stability, and third-party platform availability remained implementation dependencies.

The activity plans and virtual environment were aligned with the intended competency outcomes and the five VISTA stages. The seven physical zones supported communication, presentation, feedback, and revision during the mission-based workflow, as illustrated in Figure 6.

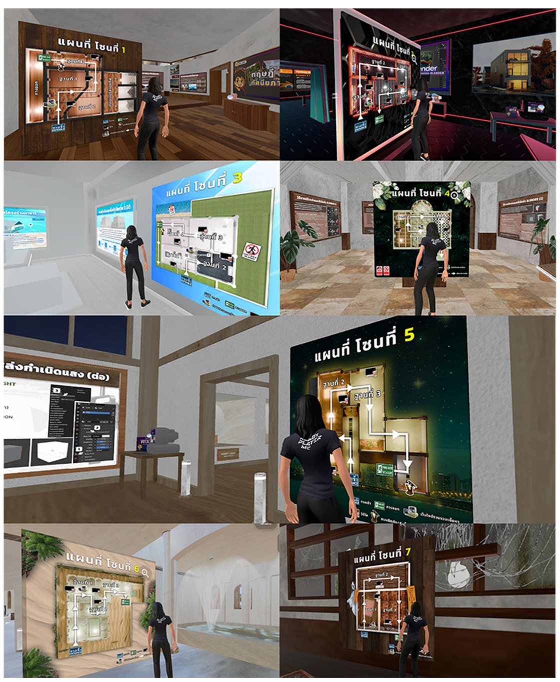


*Figure 6: Activities in the seven physical zones*

### 6.3 Implementation Results

The implementation involved 15 graduate students. Results are presented in the sequence used for analysis: inter-rater reliability, pretest-posttest competency change, posttest competency profile, completed-project quality, the association between posttest competency and project quality, and learner satisfaction.

#### 6.3.1 Inter-rater reliability

The two author-raters scored all performance evidence independently. Table 7 presents the inter-rater reliability estimates for the pretest, posttest, and completed-project assessments.

*Table 7: Inter-Rater Reliability of the Performance Assessments*

| Assessment | ICC estimate | 95% CI | Level |
|---|---|---|---|
| Pretest competency scores | .82 | [.54, .94] | Good |
| Posttest competency scores | .91 | [.75, .97] | Excellent |
| Completed-project quality scores | .88 | [.66, .96] | Good |

The principal investigator and second author independently scored the pretest, posttest, and completed-project evidence using the corresponding analytic rubrics. They recorded ratings separately and did not discuss individual scores before finalizing their initial judgments. The coefficients were .82, 95% CI [.54, .94], for pretest competency; .91, 95% CI [.75, .97], for posttest competency; and .88, 95% CI [.66, .96], for completed-project quality. Agreement was good for the pretest and completed projects and excellent for the posttest.

#### 6.3.2 Pretest-posttest changes in 3D scene creation competencies

To examine changes in learners' 3D scene creation competencies, the mean scores from the two independent raters were compared between the pretest and posttest. Table 8 summarizes the results for each competency dimension and the overall score.

*Table 8: Comparison of Pretest and Posttest 3D Scene Creation Competency Scores*

| Competency | Pretest M (SD) | Posttest M (SD) | Mean Difference |
|---|---|---|---|
| 3D Modeling | 3.05 (0.58) | 4.47 (0.32) | 1.42 |
| 3D Scene Composition | 2.92 (0.61) | 4.52 (0.33) | 1.60 |
| Material and Texturing | 2.73 (0.56) | 4.31 (0.27) | 1.58 |
| Lighting and Atmosphere | 2.66 (0.59) | 4.24 (0.30) | 1.58 |
| Testing and Improvement | 2.88 (0.54) | 4.72 (0.24) | 1.84 |
| **Overall** | **2.85 (0.49)** | **4.45 (0.21)** | **1.60** |

Note. n = 15. Scores are the mean of the two independent raters; mean difference = posttest mean minus pretest mean.

The overall competency score was higher at posttest (M = 4.45, SD = 0.21) than at pretest (M = 2.85, SD = 0.49). The overall mean difference was

1.60 points, 95% CI [1.35, 1.85], $t(14) = 13.48$, $p < .001$, Cohen's $d_z = 3.48$. Dimension-level differences in Table 8 are descriptive and were not tested separately.

### 6.3.3 Posttest competency profile

To describe learners' performance after completing the training, the posttest scores were examined across the five dimensions of 3D scene creation competency. Table 9 summarizes the criterion-level, dimension-level, and overall results based on the two raters' independent assessments.

*Table 9: Posttest Profile of Learners' 3D Scene Creation Competencies*

| 3D Scene Creation Skills | Evaluation Results | | |
|---|---|---|---|
| | ***Mean*** | ***SD*** | **Level** |
| **1. 3D Modeling Skills** | | | |
| 1.1 Creates accurate 3D models that meet design requirements. | 4.53 | 0.52 | Highest |
| 1.2 Applies appropriate modeling techniques and tools. | 4.47 | 0.52 | High |
| 1.3 Maintains correct geometry and proportions of 3D objects. | 4.40 | 0.51 | High |
| 1.4 Produces optimized models suitable for real-time rendering. | 4.33 | 0.49 | High |
| 1.5 Completes the assigned 3D models within the specified requirements. | 4.60 | 0.51 | Highest |
| **Dimension Mean** | **4.47** | **0.32** | **High** |
| **2. 3D Scene Composition Skills** | | | |
| 2.1 Arranges 3D objects appropriately within the scene. | 4.60 | 0.51 | Highest |
| 2.2 Creates balanced spatial composition and visual hierarchy. | 4.53 | 0.52 | Highest |
| 2.3 Organizes environmental elements logically and consistently. | 4.47 | 0.52 | High |
| 2.4 Designs scenes that effectively communicate the intended concept. | 4.40 | 0.51 | High |
| 2.5 Produces coherent and visually appealing 3D scenes. | 4.60 | 0.51 | Highest |
| **Dimension Mean** | **4.52** | **0.33** | **Highest** |
| **3. Material and Texturing Skills** | | | |
| 3.1 Selects appropriate materials for different objects. | 4.33 | 0.49 | High |
| 3.2 Applies textures accurately to 3D models. | 4.40 | 0.51 | High |
| 3.3 Adjusts texture mapping and UV coordinates correctly. | 4.27 | 0.46 | High |
| 3.4 Supports realism through suitable material properties. | 4.20 | 0.41 | High |
| 3.5 Maintains visual consistency of materials and textures throughout the scene. | 4.33 | 0.49 | High |
| **Dimension Mean** | **4.31** | **0.27** | **High** |
| **4. Lighting and Atmosphere Skills** | | | |
| 4.1 Selects appropriate lighting techniques for the scene. | 4.20 | 0.56 | High |
| 4.2 Uses light intensity, direction, and color effectively. | 4.27 | 0.46 | High |
| 4.3 Creates realistic shadows and environmental effects. | 4.13 | 0.52 | High |
| 4.4 Establishes an atmosphere that supports the intended mood. | 4.33 | 0.49 | High |
| 4.5 Supports depth and realism through lighting design. | 4.27 | 0.46 | High |
| **Dimension Mean** | **4.24** | **0.30** | **High** |
| **5. Testing and Improvement Skills** | | | |
| 5.1 Evaluates the quality of completed 3D scenes. | 4.73 | 0.46 | Highest |
| 5.2 Identifies design and technical issues systematically. | 4.67 | 0.49 | Highest |
| 5.3 Revises the scene based on instructor and peer feedback. | 4.80 | 0.41 | Highest |
| 5.4 Improves the quality of the final 3D scene through iterative refinement. | 4.67 | 0.49 | Highest |
| 5.5 Produces a final scene that meets the required quality standards. | 4.73 | 0.46 | Highest |
| **Dimension Mean** | **4.72** | **0.24** | **Highest** |
| **Overall Mean** | **4.45** | **0.21** | **High** |

Table 9 shows a high overall posttest competency level (M = 4.45, SD = 0.21). Testing and Improvement had the highest dimension mean (M = 4.72, SD = 0.24), followed by 3D Scene Composition (M = 4.52, SD = 0.33) and 3D Modeling (M = 4.47, SD = 0.32). Material and Texturing (M = 4.31, SD = 0.27) and Lighting and Atmosphere (M = 4.24, SD = 0.30) were lower but remained within the high range. At the criterion level, revision based on instructor and peer feedback had the highest mean (M = 4.80, SD = 0.41), whereas realistic shadows and environmental effects had the lowest mean (M = 4.13, SD = 0.52).

### 6.3.4 Quality of the completed 3D scene projects

To examine learners' ability to apply their 3D scene creation competencies to an authentic production task, the completed projects were evaluated using an analytic project-quality rubric.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

The two author-raters independently assessed the coded projects, and the mean of their ratings was used for the descriptive analysis presented in Table 10.

*Table 10: Quality of the Completed 3D Scene Projects*

| Assessment Criteria | Evaluation Results | | |
|---|---|---|---|
| | ***Mean*** | ***SD*** | **Level** |
| Accuracy and quality of 3D modeling | 4.53 | 0.52 | Highest |
| Effectiveness of 3D scene composition | 4.60 | 0.51 | Highest |
| Appropriateness of materials and texturing | 4.40 | 0.51 | High |
| Quality of lighting and atmosphere | 4.33 | 0.49 | High |
| Testing, technical optimization, and functionality | 4.73 | 0.46 | Highest |
| Creativity and visual aesthetics | 4.47 | 0.52 | High |
| Consistency with the assigned mission | 4.67 | 0.49 | Highest |
| **Overall Mean** | **4.53** | **0.28** | **Highest** |

Table 10 shows that the completed 3D scene projects were rated at the highest interpretation level overall (M = 4.53, SD = 0.28). The strongest areas were testing, technical optimization, and functionality (M = 4.73, SD = 0.46), consistency with the assigned mission (M = 4.67, SD = 0.49), and scene composition (M = 4.60, SD = 0.51). Modeling accuracy and quality also received a highest-level rating (M = 4.53, SD = 0.52).

Creativity and visual aesthetics (M = 4.47, SD = 0.52), materials and texturing (M = 4.40, SD = 0.51), and lighting and atmosphere (M = 4.33, SD = 0.49) were rated at a high level but were comparatively lower. This pattern paralleled the posttest profile, in which Testing and Improvement was the strongest dimension and Lighting and Atmosphere was the lowest.

To examine the correspondence between process-oriented competency and product-oriented performance, Pearson's correlation analysis was conducted between learners' overall posttest competency scores and completed-project quality scores. Both variables were calculated using the mean of the two independent raters' scores.

*Table 11: Association Between Posttest Competency and Completed-Project Quality*

| Variables | r | p | Level |
|---|---|---|---|
| Posttest 3D scene creation competency × completed-project quality | .78 | < .001 | Strong positive association |

*Note. n = 15.*

Table 11 shows a strong positive association between posttest 3D scene creation competency and completed-project quality, r = .78, 95% CI [.45, .92], p < .001. The Spearman sensitivity analysis yielded a similar result, ρ = .75, p = .001. Thus, participants with higher posttest competency scores tended to have higher project-quality scores.

This convergence suggests that the process-oriented and product-oriented assessments captured related aspects of 3D production performance. However, the association should be interpreted cautiously because the sample was small and some rubric criteria were conceptually overlapping.

### 6.3.5 Learners' satisfaction with the VISTA training model

Learners' satisfaction was assessed after completing the mission-based training activities in the virtual world learning environment. The questionnaire examined three aspects: the training process and mission-based learning activities, the virtual world learning environment, and perceived learning outcomes and overall satisfaction. The results are presented in Table 12.

*Table 12: Learners' Satisfaction with the VISTA Training Model*

| Satisfaction Aspects and Evaluation Items | ***Mean*** | ***SD*** | **Level** |
|---|---|---|---|
| **1. Training Process and Mission-Based Learning Activities** | | | |
| 1.1 The training objectives and expected outcomes were clearly explained. | 4.80 | 0.41 | Highest |
| 1.2 The mission scenarios were relevant, meaningful, and consistent with authentic 3D production tasks. | 4.87 | 0.35 | Highest |
| 1.3 The five stages of the VISTA Training Model were systematic and easy to follow. | 4.80 | 0.41 | Highest |
| 1.4 The mission-based activities encouraged active participation, planning, and problem-solving. | 4.80 | 0.56 | Highest |
| **Aspect Mean** | **4.82** | **0.34** | **Highest** |
| **2. Virtual World Learning Environment** | | | |
| 2.1 The virtual world learning environment was engaging and appropriate for the training activities. | 4.73 | 0.46 | Highest |
| 2.2 The interface and navigation were clear and easy to use. | 4.73 | 0.59 | Highest |
| 2.3 The virtual learning spaces effectively supported exploration and practical activities. | 4.80 | 0.41 | Highest |
| 2.4 The environment supported communication and collaboration among learners. | 4.80 | 0.41 | Highest |
| **Aspect Mean** | **4.77** | **0.40** | **Highest** |
| **3. Perceived Learning Outcomes and Overall Satisfaction** | | | |

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| Satisfaction Aspects and Evaluation Items | *Mean* | *SD* | Level |
|---|---|---|---|
| 3.1 The training activities enabled learners to apply knowledge and skills in authentic 3D scene creation tasks. | 4.80 | 0.41 | Highest |
| 3.2 The training encouraged creativity and confidence in creating complete 3D scenes. | 4.87 | 0.35 | Highest |
| 3.3 The acquired knowledge and skills can be applied to future projects or professional practice. | 4.80 | 0.41 | Highest |
| 3.4 Overall, I was satisfied with the VISTA Training Model. | 4.80 | 0.41 | Highest |
| **Aspect Mean** | **4.82** | **0.35** | **Highest** |
| **Overall Mean** | **4.80** | **0.40** | **Highest** |

Table 12 shows that learner satisfaction was at the highest level overall (M = 4.80, SD = 0.40). The training process and perceived learning outcomes both had aspect means of 4.82, while the virtual world environment had M = 4.77. Interface and navigation had the largest item-level variability (M = 4.73, SD = 0.59), whereas the mission scenarios and perceived support for creativity and confidence received the highest item means (M = 4.87, SD = 0.35).

## 7. DISCUSSION

This study developed the VISTA Training Model as a mission-based virtual-world approach to 3D scene creation. The model integrates mission analysis, production planning, Blender-based 3D production, presentation and collaboration in Spatial, formative feedback, iterative revision, and performance assessment through five interconnected stages and five functional areas distributed across seven physical zones. The following interpretation focuses on design coherence, within-group change, assessment convergence, project performance, technological implementation, and learner experience. Because the implementation used a one-group pre-experimental design, the discussion does not treat the observed pretest-posttest difference as proof of causal effectiveness.

### 7.1 Design and Applied Information Technology Contribution

The VISTA Training Model extends the use of virtual world technology beyond content presentation by positioning the environment as an integrated workspace for planning, production, collaboration, feedback, and assessment. Learners moved between Blender as the primary 3D production tool and Spatial as the virtual environment for mission briefing, resource exploration, progress presentation, peer interaction, and final evaluation. This workflow connected individual content production with synchronous virtual-world interaction and enabled the learning activities to follow a complete 3D scene production process.

The seven physical zones were organized into five functional areas mapped directly onto the VISTA stages, supporting orientation, mission analysis, production planning, work-in-progress presentation, feedback, and revision. This mapping configured the virtual environment around the instructional workflow rather than using it solely as a content-delivery or presentation platform.

Expert ratings indicated that the model, activity plans, and virtual world environment were perceived as appropriate and aligned. This result supports design coherence, but expert appraisal alone cannot establish instructional effectiveness.

Conceptually, the model operationalizes principles shared by authentic, situated, experiential, and feedback-oriented learning [27]-[33], [37], [40]-[47]. Its theoretical contribution is not the introduction of a new learning principle in isolation, but the alignment of these principles with a mission-to-production workflow. The present design cannot determine which component contributed most to the observed pattern; component-level effects require comparative research.

### 7.2 Changes in 3D Scene Creation Competencies

The overall competency score was higher at posttest, and descriptive increases were observed across all five dimensions. Testing and Improvement showed the largest descriptive increase (1.84), followed by 3D Scene Composition (1.60). Material and Texturing and Lighting and Atmosphere were tied (1.58), while 3D Modeling showed the smallest increase (1.42).

Testing and Improvement showed the largest mean increase. This pattern is consistent with the Assess, Adjust and Apply stage, which required learners to examine technical and visual problems, respond to feedback, revise scene elements, and evaluate whether the completed work satisfied the assigned mission. It also accords with literature emphasizing formative feedback, self-evaluation, peer assessment, and revision in practical and self-regulated learning [27], [28], [37]. Repeated evaluation and revision may have encouraged more systematic quality-control practices; however, the frequency and quality of feedback were not

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

experimentally varied, so this remains a plausible explanation rather than a demonstrated mechanism.

The smallest increase occurred in 3D Modeling, although the posttest score remained high. Participants entered the program with introductory familiarity with 3D modeling, which may have left less room for change than in competencies involving systematic testing, feedback, and refinement. The result may also indicate that the VISTA workflow emphasized integration across production stages more than isolated introductory modeling operations. These explanations were not directly tested.

Material and Texturing and Lighting and Atmosphere showed substantial descriptive increases but remained the comparatively lower posttest dimensions. These competencies combine technical procedures with aesthetic judgment, including surface properties, visual consistency, light direction, shadows, environmental effects, and mood. The uneven profile is important because it shows that a high overall score did not eliminate domain-specific difficulty. More focused demonstrations, reference examples, specialized missions, and critique sessions may be needed in these areas.

### 7.3 Independent Rating and Assessment Reliability

The principal investigator and second author independently evaluated the pretest performances, posttest performances, and completed projects. Inter-rater reliability ranged from good to excellent across the three assessments. The posttest competency ratings showed the highest reliability, followed by the completed-project ratings and pretest ratings.

The pretest coefficient was lower than the posttest coefficient, but the confidence intervals were wide and overlapping. With only 15 cases, differences among the coefficients should not be overinterpreted. Less differentiated novice performance may have contributed to lower pretest agreement, while completed posttest artifacts may have provided clearer evidence for applying the rubric.

Independent scoring preserved both raters' judgments and allowed inter-rater reliability to be estimated. However, both raters were members of the research team, and the principal investigator also conducted the training. Future studies should therefore include external 3D production assessors.

### 7.4 Posttest Performance and Completed-Project Quality

The posttest competency profile showed the strongest performance in Testing and Improvement, followed by 3D Scene Composition and 3D Modeling. The scores were highest for Testing and Improvement, indicating comparatively stronger performance in evaluation, revision, and technical refinement.

The completed-project quality results showed a similar pattern. Testing, technical optimization, and functionality received the highest evaluation, followed by consistency with the assigned mission, scene composition, and modeling quality. Materials, texturing, lighting, atmosphere, and visual aesthetics received comparatively lower scores but remained at a high level. The similar profiles across the two assessments suggest that performance during the posttest was reflected in the completed projects.

Posttest competency was strongly associated with completed-project quality, and the Spearman sensitivity analysis produced a similar result. This convergence is consistent with the rationale for combining process-oriented and product-oriented evidence in authentic performance assessment [40]-[47]. Nevertheless, the small sample and overlap between some rubric criteria may have increased the observed association, so the coefficient should not be interpreted as evidence that one assessment caused the other.

### 7.5 Virtual World Implementation and Learner Experience

Learner satisfaction was rated at the highest level. The highest-rated features were the authentic mission scenarios, opportunities for hands-on application, and perceived support for creativity and confidence. These ratings indicate acceptability to the participating group, but satisfaction alone does not demonstrate learning effectiveness.

The virtual world environment supported communication, collaboration, presentation, and feedback without requiring specialized virtual reality equipment. Browser access improved practical accessibility, while avatar-based interaction and shared spaces provided a common setting for discussing production decisions and presenting scenes. This pattern is consistent with reviews reporting that immersive and virtual-world environments can support engagement, spatial interaction, and collaboration when the pedagogy and implementation conditions are well aligned [2]-[4], [13]-[17].

Interface and navigation had one of the lowest item means and the greatest variability. Prior experience with virtual platforms and 3D tools, account management, network conditions, and device performance may have influenced participation. The Virtual Orientation stage should therefore include technical guides, practice spaces, troubleshooting procedures, and minimum device requirements.

The educational value of the virtual world relied on its congruence with clear goals, authentic missions, structured production processes, feedback mechanisms and performance criteria. If this alignment is not achieved, the environment becomes primarily a presentation space rather than an integrated learning and production space.

### 7.6 Theoretical and Practical Implications and Reproducibility

From an instructional-design perspective, the VISTA Training Model demonstrates how authentic missions, virtual-world interaction, formative feedback, and performance assessment can be organized around a complete 3D production workflow. Practically, it provides educators and instructional designers with a structured framework that may be adapted for digital media production, game-environment design, architectural visualization, virtual exhibitions, simulation development, and immersive educational content. Such adaptation would require changes to mission scenarios, technical tools, performance standards, and task complexity.

In this implementation, the instructor's role extended beyond software demonstration to mission guidance, production planning, and formative feedback. Learners assumed greater responsibility for selecting resources, managing production processes, evaluating quality, and explaining design decisions. These practices may support learner autonomy and professional production habits, although transfer beyond the immediate training context was not measured.

From a system-design perspective, future implementations should document technical requirements, software versions, supported file formats, device specifications, network conditions, and content-transfer procedures. Functional testing should also include access, navigation, communication, screen sharing, 3D content import, rendering, presentation, feedback, and project submission. Including these details would strengthen the reproducibility and applied information technology contribution of the model.

## 8. CONCLUSION AND FUTURE WORK

This study developed and evaluated the VISTA Training Model, a mission-based virtual-world approach that integrates mission analysis, production planning, Blender-based 3D creation, collaboration and presentation in Spatial, feedback, revision, and performance assessment. Its principal contribution is an integrated mission-to-production workflow comprising five iterative stages and five functional areas distributed across seven physical zones.

Experts rated the model, activity plans, and virtual world environment as highly appropriate and aligned. Within the participating group, the overall posttest competency score was higher than the pretest score, completed projects were rated highly, posttest competency was strongly associated with project quality, and learner satisfaction was high. Testing and Improvement was the strongest performance area, whereas materials, texturing, lighting, and atmosphere remained comparatively more challenging. These findings provide preliminary evidence of feasibility and implementation coherence rather than proof of causal effectiveness.

For practice, the model provides a sequence for instructors who need to coordinate mission briefing, production planning, Blender-based authoring, virtual presentation, feedback, revision, and rubric-based assessment. The comparatively lower scores for materials, texturing, lighting, and atmosphere indicate where additional demonstrations, guided practice, and critique may be needed.

Interpretation is limited by the small volunteer sample from one academic program, the absence of a comparison group, immediate post-training measurement, and the use of two author-raters. The principal investigator's dual role as trainer and rater could also have introduced expectancy or response bias, and conceptual overlap between the competency and project-quality rubrics may have strengthened their correlation. Future research should use larger and more diverse samples, comparison or quasi-experimental designs, external assessors, delayed retention and transfer measures, and analyses that distinguish the contributions of individual model components. Further development should also provide targeted support for materials, texturing, lighting, and atmosphere and evaluate usability under varied device and network conditions.

## CONFLICT OF INTEREST

The authors declare no financial or non-financial conflicts of interest that could have influenced the research, authorship, or publication of this article.

## AUTHOR CONTRIBUTIONS

Parwapun Kamtab contributed to the conceptualization and overall design of the study; development of the VISTA Training Model and mission-based learning activities; research methodology and instrument design; coordination of expert validation; participant recruitment and training implementation; investigation and data collection; data curation, formal analysis, and interpretation of the findings; preparation of figures, tables, and other research materials; project administration and supervision; and drafting the manuscript, including review and editing.

Weerakron Chareansuk contributed to the technical design, development, testing, validation, implementation, and revision of the Virtual World Learning Environment; the preparation of related technical visual materials; and the independent scoring of the coded pretest, posttest, and completed-project evidence using the analytic rubrics.

Both authors reviewed and approved the final version of the manuscript and agreed to be accountable for all aspects of the work, ensuring the accuracy and integrity of the research.

## ACKNOWLEDGMENT

The authors sincerely thank the experts, participating graduate students, and the Faculty of Technical Education, King Mongkut's University of Technology North Bangkok, for their evaluation, feedback, and institutional support.

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