Application and Optimization Research of Game Engines in Interactive Courseware Production

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Abstract. Traditional courseware suffers from limited interactivity and visual presentation, failing to meet the demands of application-oriented digital media education. This study employs Unreal Engine to develop interactive courseware for a Film Editing course. Compared with PowerPoint-based courseware, the UE-based courseware demonstrates clear advantages in interactivity, non-linear navigation, and visual effects. However, production time reaches 121 hours for the first module, primarily consumed by blueprint logic and Widget interface design. Three optimization strategies are proposed: resource sharing, workflow streamlining, and cross-disciplinary collaboration. These strategies reduced subsequent production cycles by 22%–72%, yet the time ultimately converges to approximately ten times that of PowerPoint, indicating persistent rigid costs. The study provides practical reference for courseware digitization in art and design education.

Keywords: Courseware Production; Game Engine; Interactive Courseware; Digital Media Technology;

1 Introduction

1.1 Research Background and Problem Proposal

Courseware serves as a core vehicle for knowledge delivery, and its quality directly affects teaching effectiveness. Traditional tools, such as PowerPoint, are primarily characterized by linear presentation formats and suffer from inherent limitations in interactivity and visual representation. Consequently, they prove inadequate for effectively engaging students within practice-oriented disciplines, such as digital media technology. Game engines, integrating real-time rendering, physics simulation, and visual scripting, offer new possibilities for interactive courseware development[1].

However, a critical challenge emerges: how to balance the interactive advantages of game engines with their substantially higher production costs. Initial attempts reveal that while UE-based courseware excels in interactivity, its production cycle far exceeds that of conventional tools. Existing research focuses primarily on virtual teaching scenarios or 3D courseware development, with insufficient attention to cost-efficiency

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trade-offs. This study addresses this gap by systematically examining the design, cost structure, and optimization of UE-based interactive courseware, using a Film Editing courseware series as a case study.

1.2 Research Content and Significance

In view of this, this paper takes Unreal Engine (UE) as the development platform and the series of courseware for "Film and Television Editing" in the digital media technology major as cases, to systematically study the design and implementation methods, production cost composition and optimization strategies of interactive courseware based on game engines. The research aims to answer the following questions: How to realize the core advantages of game engine courseware through specific design? In which links are the production costs mainly reflected? What strategies can be used to effectively reduce costs and improve efficiency? The development of this research has practical reference value for promoting the innovation of courseware in the digital media technology major and exploring the efficient application path of game engines in the field of education.

2 Theoretical and Technical Foundations

2.1 Key Technologies of Game Engines and Their Educational Applicability

A game engine is an integrated development environment for creating interactive digital content, incorporating core functionalities such as real-time rendering, physics simulation, interaction logic, and resource management[2]. Currently, Unreal Engine and Unity are the two most widely adopted engines in the education domain. Among them, Unreal Engine holds a distinct advantage in teaching scenarios that demand high-quality visual presentation, owing to its superior graphics rendering capabilities and its visual Blueprint scripting system[3].

In educational applications, game engines can be used not only to construct three-dimensional virtual scenes but, more importantly, their visual programming tools enable developers to rapidly build interaction logic by connecting nodes, substantially reducing the complexity of coding[4]. This allows instructors from non-computer disciplines to participate in the preliminary interactive design of courseware after training[5]. Furthermore, the real-time rendering capability provides visual support for demonstrating complex professional concepts—such as color composition, camera movement, and lighting effects—that traditional courseware can hardly match.

2.2 Design Principles and Requirements of Interactive Courseware

The design of interactive courseware is grounded in constructivist learning theory, which emphasizes that learners construct knowledge through active interaction with learning content. The core design principles include: learner-centeredness, providing space for active exploration; a focus on immediate feedback to help learners establish correct cognitive connections; and support for non-linear navigation, enabling personalized learning path choices.

For certain disciplines, courseware must also meet specific instructional requirements: the ability to intuitively display visual effects, present compositional principles in three-dimensional space, and simulate real-world project workflows. These requirements place high demands on the visual expressiveness, dynamic demonstration capability, and depth of interactivity of the courseware—demands that traditional linear courseware struggles to fulfill[6].

3 Design and Implementation

3.1 Requirements and Architecture

The Film Editing course covers montage theory, film history, and editing techniques. Traditional PowerPoint courseware is constrained by static images, linear page progression, and limited capacity to demonstrate dynamic visual effects. The UE-based courseware was designed to achieve non-linear navigation across modules, interactive video playback, comparative case demonstrations, and professional visual presentation.

A hub-and-spoke navigation architecture was adopted, where the main menu serves as the central hub, allowing students to freely access any module—Montage, Film History, or Cinematic Language. Cross-referencing buttons at key knowledge points enable direct jumps to related cases, realizing fully non-linear learning paths.

Taking the Montage module as an example, each module is further subdivided according to different knowledge points, such as narrative montage, expressive montage, and intellectual montage, with free navigation supported among these sub-topics to facilitate comparative learning. The courseware architecture and non-linear interaction design are illustrated in Figure 1.

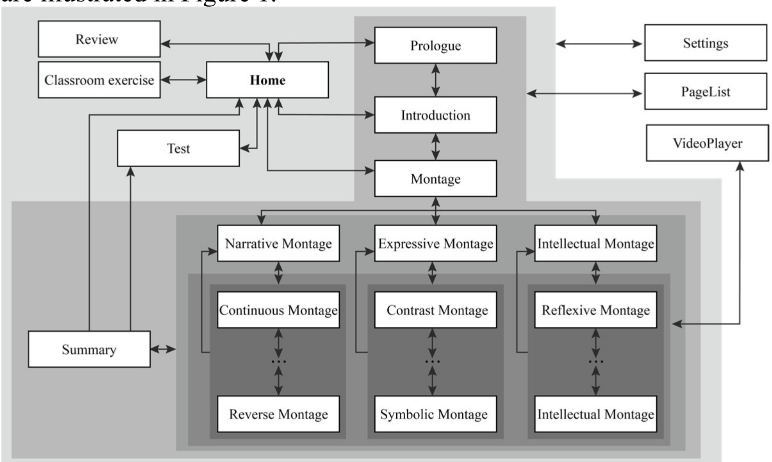

Fig. 1. Courseware Architecture and Non-linear Interaction Design.

3.2 Design Principles and Requirements of Interactive Courseware

The courseware was developed using Unreal Engine 5, employing four core modules: the Widget system for constructing all 2D user interfaces; Blueprint visual scripting for implementing all interactive logic without C++ coding; the Media Player framework for embedding and controlling instructional videos; and animation and transition effects via Sequencer. Visual comparison between PowerPoint and UE-based courseware is illustrated in Figure. 2.

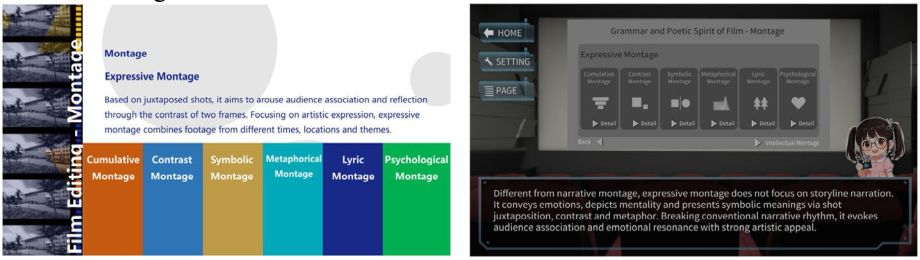

Fig. 2. Visual comparison between PowerPoint and UE-based courseware.

4 Cost Analysis and Optimization

4.1 Production Cost Benchmarks

The first courseware module, Montage, required 4 hours using PowerPoint versus 121 hours using UE. Table 1 presents the time distribution for UE production.

Table 1. Time Distribution of UE Production for "Montage" Courseware.

Task	Completion Time/h	Time Proportion
Scene Construction	20	17%
Blueprint Design	32	26%
Widget Design	33	27%
Animation Design	13	11%
Component Design	15	12%
Other Work	8	7%

Blueprint design and Widget design together account for 53% of total time, primarily because the initial development required building the entire interaction framework and interface component library from scratch. For art and design instructors, mastering these technical skills presents a steep learning curve, further inflating production time.

4.2 Optimization Strategies and Validation

Three optimization strategies were proposed and validated through subsequent courseware production:

Strategy 1: Resource-sharing platform. The Widget templates, reusable Blueprint modules (e.g., main menu system, video player, navigation controls), and scene templates created in the first module were archived for reuse, eliminating redundant development.

Strategy 2: Streamlined workflow. Instructor training focused narrowly on high-frequency functions rather than comprehensive engine operation. New courseware production was simplified to content replacement, layout adjustment, and testing.

Strategy 3: Cross-disciplinary collaboration. Course design was led by digital media instructors, while technical implementation was supported by computer science faculty, distributing the technical burden.

This architecture realizes a completely non-linear learning path. Students do not need to browse in a fixed order, but can independently choose learning content according to their own interests and weak links, reflecting the learner-centered design concept.

Table 2 presents a comparative analysis of courseware production time between PowerPoint and Unreal Engine (UE) across seven sequential courseware modules. The results demonstrate a notable downward trend in UE production time, which dropped from 121 hours for the initial module (Courseware 1) to 94 hours for Courseware 2, representing a 22% time reduction, and further decreased to 53.7 hours for Courseware 3. The PPT/UE time ratio accordingly rose from 0.033 to 0.106 in the early production stage, verifying the positive effects of reusable resource utilization and standardized workflow optimization on improving development efficiency. Nevertheless, the efficiency improvement reached a saturation point starting from Courseware 5. The production time of UE courseware stabilized at 34 to 45 hours for subsequent modules, which was approximately tenfold the time required for PowerPoint development. This stable efficiency gap indicates that the inherent time cost incurred by customized content refinement for UE courseware cannot be fully eliminated through routine process optimization.

Empirical feedback from teachers and students further validates the distinct strengths and limitations of the two tools in practical teaching applications. Student participants reported that UE-based courseware delivered superior immersive learning experiences, with prominent improvements in classroom engagement and learning attention retention. Instructors meanwhile recognized the high flexibility and interactive scalability of UE courseware for diversified teaching scenarios, but consistently pointed out that UE courseware development remained substantially more time-intensive than traditional PowerPoint-based production throughout the whole series development process.

The dual evaluation results of student experience and instructor production experience reveal a typical trade-off relationship between courseware production cost and teaching effect. PowerPoint, as a mature and lightweight courseware production tool, has simple operation logic and low learning and use costs, which can quickly complete conventional courseware production and meet basic classroom teaching needs. In contrast, UE's powerful three-dimensional presentation and interactive teaching capabilities make up for the flat and single display defects of traditional PPT courseware, effectively stimulating students' learning interest and improving classroom learning concentration. Nevertheless, its complex operation logic, high production threshold and unavoidable customized adjustment costs lead to much higher time investment than traditional tools. This indicates that in practical teaching application, UE is more suitable for high-quality, scenario-based and interactive teaching scenarios with high effect requirements and sufficient production cycle, while PowerPoint still retains irreplaceable advantages in daily conventional and efficient courseware production tasks.

Table 2. Comparison of Production Time between PowerPoint and UE for Series Courseware.

Courseware	PPT	UE	Time Ratio (PPT/UE)
Courseware 1	4	121	0.033
Courseware 2	4.5	94	0.048
Courseware 3	2.5	53.7	0.047
Courseware 4	3.7	62	0.060
Courseware 5	4.1	45	0.091
Courseware 6	3.6	34	0.106
Courseware 7	4.6	44	0.105

5 Conclusion

This study validates the value of Unreal Engine in interactive courseware development, demonstrating its advantages in interactivity, non-linear navigation, and visual effects over PowerPoint. However, blueprint logic and Widget design account for the majority of production time, representing structural cost bottlenecks. The proposed optimization strategies reduced subsequent production cycles by 22%–72%, yet the time required ultimately converges to approximately ten times that of PowerPoint, indicating that rigid content customization costs and technical barriers remain persistent challenges. Limitations include the narrow disciplinary scope, reliance on subjective feedback, and limited sample size. Future work will extend the application to broader disciplines and explore dedicated authoring tools to fundamentally lower the technical threshold.

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