

Introduction To 3d Game Programming With Directx 11

Introduction to 3D Game Programming with DirectX 11 3D game programming is a complex and rewarding field that combines elements of graphics rendering, physics simulation, input handling, and game logic to create immersive interactive experiences. Among the many graphics APIs available, DirectX 11, developed by Microsoft, stands out as a widely adopted and powerful platform for developing high-performance 3D games on Windows. This article provides a comprehensive introduction to 3D game programming with DirectX 11, guiding you through its core concepts, essential components, and best practices to help you get started on your journey into 3D game development.

Understanding the Basics of 3D Graphics Programming

What is 3D Graphics Programming?

3D graphics programming involves creating and rendering three-dimensional objects, environments, and effects in a virtual space. It requires understanding how to represent geometry, manipulate objects through transformations, and apply visual effects such as lighting and textures to produce realistic or stylized scenes.

Core Concepts in 3D Graphics

- Vertices and Primitives: The building blocks of 3D models; vertices define points in space, and primitives (triangles, lines, points) connect them. - Coordinate Systems and Transformations: Objects are positioned, rotated, and scaled within different coordinate spaces—model, world, view, and projection. - Camera and Viewing: Defines how the scene is viewed, including perspective projection and camera positioning. - Lighting and Shading: Simulates light interaction with surfaces to produce realistic effects. - Textures and Materials: Adds surface detail and color information to models.

Introduction to DirectX 11

What is DirectX 11?

DirectX 11 is a low-level API designed for high-performance multimedia and game development on Windows platforms. It provides developers with control over GPU resources and rendering pipelines, enabling the creation of complex, real-time 3D graphics.

Advantages of Using DirectX 11

- Hardware Acceleration: Leverages GPU capabilities for rendering. - Advanced Features: Support for tessellation, compute shaders, multi-threading, and more. - Compatibility: Works across a wide range of Windows devices. - Rich Ecosystem: Extensive documentation, tools, and community support.

Key Components of DirectX 11

- Device and Device Context: Interfaces to interact with GPU hardware. - Swap Chain: Manages buffers for rendering frames to the screen. - Render Target and Depth Stencil Views: Textures that represent the rendering surface and depth buffer. - Shaders: Small programs that run on the GPU to control rendering. - Input Layouts: Define how vertex data is interpreted by shaders. - Constant Buffers: Store uniform data sent to shaders.

Setting Up a Basic DirectX 11 Application

Prerequisites

- Familiarity with C++ programming. - Visual Studio IDE (preferably the latest version). - Windows SDK installed. - Basic understanding of graphics programming concepts.

Creating a Window

Start by creating a Win32 application window that will serve as the rendering surface. This includes defining the window class, creating the window handle, and handling the message loop.

Initializing DirectX 11

1. Create the Device and Device Context: - Use `D3D11CreateDevice` to initialize the GPU device and context. 2. Set Up the Swap Chain: - Describe buffers and create a swap chain with `IDXGIFactory` to handle front and back buffers. 3. Create Render Target View: - Retrieve the back buffer and create a render target view for rendering. 4. Configure Viewport: - Define the dimensions and depth range of the rendering area.

Basic Rendering Loop

Implement a loop that clears the render target, draws objects, and presents the frame: - Clear the screen. - Draw your 3D objects. - Call `Present` to display the frame.

Fundamental Concepts in 3D Game Programming with DirectX 11

Vertex Buffers and Index Buffers

- Store vertex data (positions, normals, texture coordinates). - Use index buffers to reuse vertices efficiently.

Shaders and the Rendering Pipeline

- Vertex Shader: Processes vertex data, applies transformations. - Pixel Shader: Calculates pixel colors, handles lighting and texturing. - Input Assembler: Reads vertex data. - Rasterizer: Converts primitives into pixels. - Output Merger: Combines pixel data for final output.

Transformations and Matrices

- Use matrices to convert model coordinates into world, view, and projection spaces. - Common matrices: - World

Matrix: Positions and orients objects. - View Matrix: Represents the camera. - Projection Matrix: Defines perspective projection.

Lighting and Materials

Implement lighting models like Phong or Blinn-Phong to simulate realistic illumination: - Ambient, diffuse, specular components. - Material properties for surface appearance.

Handling User Input and Interaction

- Capture keyboard and mouse input to move or rotate objects. - Implement camera controls for navigating the scene. - Use event handling mechanisms provided by Win32 API or other input libraries.

Advanced Features and Optimizations

Tessellation

Allows dynamic subdivision of geometry for detailed surfaces.

Compute Shaders

Enable general-purpose GPU programming for physics, AI, or post-processing effects.

Multi-threading

Distribute rendering and resource management across multiple CPU cores for better performance.

Resource Management

Efficiently load, create, and release resources such as textures, buffers, and shaders.

Best Practices in 3D Game Programming with DirectX 11

- Always check for errors during API calls. - Use efficient data structures to minimize CPU-GPU communication. - Optimize rendering by culling unseen objects. - Leverage hardware features like instancing for rendering multiple objects efficiently. - Maintain clean, modular code for scalability and maintenance.

Resources for Learning and Development

- Official Microsoft DirectX documentation. - Tutorials and sample projects on platforms like GitHub. - Books such as "Introduction to 3D Game Programming with DirectX 11" by Frank Luna. - Online courses and forums for community support.

Conclusion

Getting started with 3D game programming using DirectX 11 requires understanding the fundamental concepts of graphics rendering, the pipeline, and how to interface with GPU hardware. While it involves a steep learning curve, mastering DirectX 11 unlocks the ability to create high-performance, visually stunning 3D games and applications.

By gradually building your knowledge—from setting up the rendering environment to implementing complex effects—you can develop a solid foundation in 3D graphics programming and explore the vast possibilities it offers in game development.

Introduction to 3D Game Programming with DirectX 11 In the rapidly evolving world of game development, understanding how to harness the power of advanced graphics APIs is essential for creating immersive and visually stunning 3D games. DirectX 11 stands out as one of the most influential and widely used graphics APIs for Windows-based game development, offering developers a rich set of features to optimize graphics rendering, improve performance, and deliver compelling visual experiences. This article provides a comprehensive introduction to 3D game programming with DirectX 11, exploring its architecture, core concepts, practical implementation, and best practices. Whether you're a beginner venturing into game development or an experienced programmer looking to deepen your understanding of DirectX 11, this guide will serve as a foundational resource to help you navigate the intricacies of 3D graphics programming.

Understanding the Fundamentals of DirectX 11

What is DirectX 11?

DirectX 11 is a multimedia API developed by Microsoft, designed to handle tasks related to multimedia, particularly game programming and high-performance graphics rendering. It is part of the DirectX family, which includes APIs for audio, input, and other multimedia tasks, but DirectX 11 primarily focuses on graphics rendering. Introduced in 2009, DirectX 11 brought significant improvements over previous versions, emphasizing hardware tessellation, multi-threaded rendering, and better resource management.

Why Choose DirectX 11 for 3D Game Programming?

- Platform Optimization: Designed specifically for Windows, ensuring tight integration with Windows OS and hardware. - Advanced Features: Supports tessellation, compute shaders, multi-threading, and more, enabling high-fidelity graphics. - Performance: Improved multi-core utilization and resource management for smoother gameplay.

Core Concepts and Architecture

At its core, DirectX 11 provides a low-level interface to GPU hardware, allowing developers to control rendering pipelines explicitly. Its architecture includes:

- Device and Device Context: The device manages resources, while the device context is used to issue rendering commands.
- Swap Chain: Manages the buffers that are presented to the screen, enabling double or triple buffering for smooth rendering.
- Shaders: Small programs executed on the GPU, including vertex shaders, pixel shaders, hull shaders, domain shaders, and compute shaders.
- Resources: Textures, buffers, and other data structures used by shaders.
- Pipeline State Objects: Encapsulate the entire rendering pipeline configuration.

Setting Up a Basic 3D Application with DirectX 11

Prerequisites and Development Environment

Before diving into coding, ensure you have:

- A Windows development environment (Windows 10 or later).
- Visual Studio IDE (2019 or later recommended).
- Windows SDK installed, which includes DirectX headers and libraries.

Initializing DirectX 11

The first step in any DirectX 11 application involves creating the device, device context, and swap chain. This process includes: - Creating a window to render into, typically using Win32 API. - Setting up a swap chain description, defining buffer count, format, refresh rate, and window handle. - Calling

`D3D11CreateDeviceAndSwapChain()` to initialize the core objects. Sample Initialization Code Snippet:

```
D3D_FEATURE_LEVEL featureLevel; DXGI_SWAP_CHAIN_DESC scd = { / fill in swap chain description / };
ID3D11Device device = nullptr; ID3D11DeviceContext context = nullptr; IDXGISwapChain swapChain = nullptr;
HRESULT hr = D3D11CreateDeviceAndSwapChain( nullptr, D3D_DRIVER_TYPE_HARDWARE, nullptr, 0, nullptr, 0,
D3D11_SDK_VERSION, &scd, &swapChain, &device, &featureLevel, &context);
```

Core Components of 3D Game Programming with DirectX 11

Rendering Pipeline Overview

The rendering pipeline in DirectX 11 involves several stages: - Input Assembler: Reads vertex data and assembles primitives. - Vertex Shader: Processes vertices, transforming them into screen space. - Hull & Domain Shaders: Optional stages for tessellation, allowing dynamic detail adjustment. - Geometry Shader: Can generate new geometry on the fly. - Rasterizer: Converts primitives into pixels. - Pixel Shader: Determines pixel color and shading effects. - Output Merger: Combines outputs to produce the final pixel data.

Shaders and HLSL

Shaders are written in High-Level Shader Language (HLSL). They are compiled at runtime or ahead of time and are essential for customizing the rendering process. - Vertex Shader: Transforms 3D vertices to 2D screen coordinates. - Pixel Shader: Applies textures, lighting, and effects to pixels. - Tessellation Shaders: Enhance mesh detail dynamically. Example of a simple vertex shader: `float4 MainVS(float3 position : POSITION) : SV_POSITION { return float4(position, 1.0f); }`

Implementing 3D Graphics: Practical Considerations

Creating and Managing Resources

Resources include textures, buffers, and shaders. Proper management ensures performance and stability. - Vertex Buffers: Store vertex data. - Index Buffers: Define how vertices form primitives. - Constant Buffers: Send uniform data to shaders, such as transformation matrices or lighting parameters. - Textures: Store image data for surface details.

Camera and Transformations

Implementing a camera involves creating view and projection matrices: - View Matrix: Defines the camera position and orientation. - Projection Matrix: Converts 3D coordinates into 2D screen space with perspective. Use libraries like GLM or custom matrix math to handle these transformations.

Lighting and Material Effects

Lighting enhances realism. Common models include Phong and Blinn-Phong. Shaders calculate light reflection based on surface normals, light direction, and material properties.

Advanced Features of DirectX 11

Tessellation

Tessellation allows dynamic surface detail adjustment, improving visual fidelity without increasing mesh complexity upfront. Features include: - Hull Shader: Determines tessellation levels. - Domain Shader: Calculates positions of tessellated vertices. Pros: - Dynamic level of detail. - Improved visual quality of surfaces. Cons: - Increased GPU load if overused. - More complex shader programming.

Compute Shaders

Enable GPGPU (General-Purpose Computing on Graphics Processing Units) tasks, useful for physics calculations, particle systems, and post-processing effects.

Multi-threaded Rendering

DirectX 11 supports multi-threaded command submission, improving CPU utilization and rendering efficiency.

Best Practices and Optimization Tips

- Resource Management: Always release unused resources to prevent memory leaks. - Batch Draw Calls: Minimize state changes and draw calls for better performance. - Level of Detail (LOD): Use simplified meshes for distant objects. - Culling: Implement frustum and occlusion culling to avoid rendering unseen objects. - Profiling: Use tools like Visual Studio Graphics Diagnostics and PIX for Windows to analyze performance bottlenecks.

Challenges and Limitations of DirectX 11

- Steep Learning Curve: Requires understanding of graphics pipelines, shaders, and low-level programming. - Platform Dependency: Windows-only API limits cross-platform development. - Complex Debugging: Shader bugs and resource management issues can be difficult to diagnose. Despite these challenges, DirectX 11 remains a powerful API for desktop game development, offering fine-grained control over rendering and performance.

Conclusion and Future Outlook

Mastering 3D game programming with DirectX 11 is a rewarding endeavor that opens the door to creating visually impressive and performant games on Windows. Its advanced features like tessellation, compute shaders, and multi-threaded rendering provide developers with tools to push the boundaries of real-time graphics. While newer APIs like DirectX 12 and Vulkan offer even more control and efficiency, understanding DirectX 11 lays a solid foundation for grasping graphics programming principles. As hardware continues to evolve, so will the capabilities of DirectX, making it an enduring choice for high-fidelity game development. Whether you're building a simple 3D scene or a complex AAA title, the knowledge gained from exploring DirectX 11 will serve as a valuable stepping stone in your game development journey.

There is a moment many readers recognize, even if they rarely talk about it. A moment when a question appears unexpectedly, or when curiosity quietly interrupts routine. In the past, that moment often ended without resolution. Access was limited, time was short, and information felt distant. The option to download **Introduction To 3d Game Programming With Directx 11** has changed that experience in subtle but meaningful ways.

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Search functionality further changes expectations. Readers no longer hesitate to return to a text because locating information feels effortless. A concept, a term, or a specific idea can be found in seconds. This ease encourages frequent revisits, reinforcing memory and understanding.

Cost accessibility also shapes behavior. When knowledge is affordable or freely available through legal platforms, curiosity feels less risky. Readers explore unfamiliar topics without worrying about wasted investment. This openness often leads to unexpected discoveries and broader perspectives.

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Students experience similar benefits. Learning becomes more adaptable when materials are always within reach. Late-night revisions, last-minute reviews, or slow rereading of complex sections all become manageable. The ability to return to content repeatedly supports deeper understanding.

Different personalities approach reading differently, and downloadable formats respect those differences. Some readers prefer careful progression, while others jump between sections guided by interest. Both approaches remain valid, and neither is constrained by format.

Accessibility tools further expand participation. Adjustable text size, reading assistance features, and compatibility with support technologies ensure that more people can engage comfortably. These options quietly remove barriers that once limited access.

Organization also becomes part of the experience. Digital libraries grow over time, reflecting evolving interests and priorities. Books remain easy to locate, notes stay preserved, and learning feels cumulative rather than fragmented.

Another subtle shift lies in confidence. When readers know they can return to a resource at any time, they feel less pressure to understand everything immediately. This patience allows ideas to settle naturally, improving retention and clarity.

Global access adds richness to the experience. Readers from different backgrounds engage with the same material, often bringing unique interpretations. This shared access broadens perspectives and reminds readers that learning is a collective process.

Perhaps the most meaningful impact of downloading **Introduction To 3d Game Programming With DirectX 11** is how it changes attitude. Learning feels approachable. Curiosity feels safe. Exploration feels rewarding rather than overwhelming.

Books stop being destinations and start becoming companions. They wait patiently, ready to be opened again whenever questions return. There is no urgency, only availability.

Over time, these small interactions accumulate. Understanding deepens quietly. Interests expand naturally. Knowledge grows not through pressure, but through consistency and openness.

Accessing **Introduction To 3d Game Programming With DirectX 11** in this way does not replace traditional reading habits. It complements them, allowing learning to move at a pace that reflects real life. Pages are revisited, ideas reconsidered, and insights refined gradually.

In the end, what matters most is not how quickly information is consumed, but how comfortably it stays within reach. When knowledge feels present rather than distant, learning becomes less about effort and more about connection. And that connection often continues long after the book is first opened.

Questions & Answers About introduction to 3d game programming with directx 11

No	Question	Answer
1	What are the key features of DirectX 11 that benefit 3D game programming?	DirectX 11 introduces advanced features such as tessellation, compute shaders, multi-threading support, and improved graphics pipeline control, enabling developers to create more detailed and efficient 3D games with better performance and visual fidelity.

2	What are the basic steps to set up a 3D rendering pipeline using DirectX 11?	The basic steps include initializing the Direct3D device and swap chain, creating render targets, setting up shaders, defining input layouts, configuring the camera and projection matrices, and entering the render loop to draw 3D objects each frame.
3	How does DirectX 11 handle resource management for 3D models and textures?	DirectX 11 manages resources through the use of buffer objects, texture objects, and resource views. Developers load models and textures into GPU memory using functions like CreateBuffer and CreateTexture2D, enabling efficient rendering and updates during gameplay.
4	What are common challenges faced when starting with 3D game programming in DirectX 11?	Common challenges include understanding the graphics pipeline, managing complex resource lifecycles, optimizing performance, handling device context states, and debugging shader code. Learning to efficiently use the API and debugging tools is essential for effective development.
5	How do shaders work in DirectX 11 for 3D rendering?	Shaders in DirectX 11 are small programs written in HLSL that run on the GPU. They process vertex data (vertex shaders), compute pixel colors (pixel shaders), and can be used for advanced effects like tessellation and compute operations, enabling flexible and high-performance rendering.
6	What tools and resources are recommended for learning 3D game programming with DirectX 11?	Recommended tools include Microsoft Visual Studio for development, the DirectX SDK for sample code and documentation, and graphics debugging tools like PIX. Online tutorials, official Microsoft documentation, and community forums are also valuable resources.
7	How important is understanding mathematics (vectors, matrices) in 3D game programming with DirectX 11?	Mathematics, especially vectors and matrices, is crucial for transforming models, calculating camera movements, lighting, and physics. A solid understanding of linear algebra is essential for manipulating 3D objects and achieving realistic graphics in DirectX 11.

3D game development, DirectX 11 tutorials, graphics programming, shader programming, HLSL, rendering pipeline, 3D graphics APIs, game engine basics, GPU programming, real-time rendering

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Organizing Introduction To 3d Game Programming With DirectX 11 in digital form is an essential step to ensure long-term usability, efficiency, and easy access. As your digital library grows, unorganized files can quickly become difficult to manage, leading to wasted time searching for documents and potential loss of important information. A well-structured organization system helps you maintain control over your collection and improves productivity.

One of the simplest and most effective methods of organization is using clearly labeled folders. Create a main folder dedicated to Introduction To 3d Game Programming With DirectX 11 and divide it into subfolders based on categories such as subject, author, year, edition, or format. For example, you might organize folders by topics, academic level, or personal vs professional use. Consistent folder structures make navigation intuitive and reduce confusion.

File naming conventions play a crucial role in organization. Instead of generic file names, use descriptive and consistent naming formats. Including details such as title, author, version, and date can make files easier to identify at a glance. For example, using a format like "Title_Author_Edition_Year.pdf" ensures clarity and avoids duplicate confusion. Consistency is key—choose a naming system and apply it uniformly across all Introduction To 3d Game Programming With DirectX 11 files.

Tagging files is another powerful organizational strategy. Many operating systems and cloud storage platforms support file tags or labels. Tags allow you to categorize Introduction To 3d Game Programming With DirectX 11 across multiple dimensions without duplicating files. For example, a single document can be tagged as "study," "reference," "important," or "exam prep." This makes retrieval faster when searching your library.

For collections involving multiple volumes or editions, version control is essential. Keeping track of revisions ensures that you always know which version is the most current or authoritative. You can use version numbers in file names or create a separate folder for archived editions. This practice is especially important for academic, technical, or professional Introduction To 3d Game Programming With Directx 11 materials that may be updated regularly.

Using cloud storage for organization

Cloud storage services such as Google Drive, Dropbox, and OneDrive offer advanced tools for organizing Introduction To 3d Game Programming With Directx 11. These platforms allow folder hierarchies, tagging, search functionality, and cross-device access. Cloud storage also provides automatic backups, reducing the risk of data loss due to device failure.

Search functionality within cloud platforms is particularly valuable. Many services can search not only file names but also text within PDFs, making it easy to locate specific content inside Introduction To 3d Game Programming With Directx 11 documents. This feature saves significant time, especially when working with large libraries or research materials.

Sharing controls in cloud storage further enhance organization. You can manage access permissions, track shared links, and maintain privacy. This is useful when collaborating with others or distributing selected Introduction To 3d Game Programming With Directx 11 files while keeping the rest of your library private.

Offline Access

Offline access is one of the most important advantages of digital copies of Introduction To 3d Game Programming With Directx 11. Downloading files for offline reading ensures uninterrupted access regardless of internet availability. This is especially useful during travel, commuting, or in locations with limited or unreliable connectivity.

Most eBook platforms and cloud storage services allow users to mark files for offline access. Once downloaded, Introduction To 3d Game Programming With Directx 11 can be read, annotated, and bookmarked without an active internet connection. Changes made offline are often synced automatically once the device reconnects to the internet, ensuring continuity across devices.

Syncing devices enhances the offline experience. When your devices are connected to the same account, progress, bookmarks, highlights, and notes can be synchronized seamlessly. This means you can start reading Introduction To 3d Game Programming With Directx 11 on one device and continue on another without losing your place. Synchronization is particularly valuable for users who switch between smartphones, tablets, and computers.

To optimize offline access, it is important to manage storage space effectively. Large PDF libraries can consume significant storage, especially on mobile devices. Regularly reviewing downloaded files and removing those no longer needed helps maintain sufficient space while keeping essential Introduction To 3d Game Programming With Directx 11 materials available offline.

Backup strategies for offline libraries

Even with offline access, backups remain essential. Maintaining copies of your Introduction To 3d Game Programming With Directx 11 library on external drives or secondary cloud accounts provides additional protection against data loss. Periodic backups ensure that your organized collection remains safe and recoverable in case of device failure or accidental deletion.

Interactive Elements

Some digital versions of Introduction To 3d Game Programming With DirectX 11 go beyond static text by incorporating interactive elements designed to enhance engagement and retention. These features transform traditional reading into a more dynamic and immersive experience, particularly for educational and instructional content.

Interactive elements may include multimedia such as embedded audio, video explanations, animations, or hyperlinks to additional resources. These features provide context, demonstrations, and real-world examples that support deeper understanding. For learners, multimedia content can make complex topics easier to grasp and more memorable.

Quizzes and exercises are another common interactive feature. These elements allow readers to test their understanding of Introduction To 3d Game Programming With DirectX 11 content immediately after reading. Interactive quizzes provide instant feedback, reinforcing learning and helping identify areas that need further review. This approach is especially effective for students, trainees, and self-learners.

Some interactive Introduction To 3d Game Programming With DirectX 11 editions also include clickable tables of contents, internal navigation links, and progress indicators. These tools improve usability by allowing readers to move quickly between sections and track their progress. Enhanced navigation is particularly valuable for long or complex documents.

Device and platform compatibility

Interactive features may require specific apps or platforms to function properly. Not all PDF readers or eBook apps support advanced multimedia or interactive elements. Before downloading or purchasing an interactive version of Introduction To 3d Game Programming With DirectX 11, it is important to verify compatibility with your devices and preferred reading software.

Interactive content may also increase file size and resource usage. Devices with limited storage or processing power may experience slower performance. Understanding these requirements helps ensure a smooth reading experience without technical issues.

Balancing interactivity and focus

While interactive elements enhance engagement, moderation is important. Too many distractions can interrupt reading flow and reduce concentration. Choosing interactive Introduction To 3d Game Programming With DirectX 11 editions that balance content and features ensures that interactivity supports learning rather than detracting from it.

Some readers prefer to disable certain interactive features or use simplified reading modes when focusing on deep study. The flexibility to customize the reading experience allows users to adapt Introduction To 3d Game Programming With DirectX 11 to different contexts, such as quick review versus in-depth learning.

Best practices for managing interactive Introduction To 3d Game Programming With DirectX 11

- Keep interactive files organized separately if they require specific apps or platforms.
- Test interactive features before relying on them for study or teaching.
- Ensure offline availability if interactive content is needed without internet access.
- Maintain updated software to support multimedia and security features.
- Balance interactive use with focused reading sessions.

Long-term organization strategies

As your collection of Introduction To 3d Game Programming With DirectX 11 grows, periodically reviewing and reorganizing your library helps maintain efficiency. Removing outdated files, updating versions, and refining folder structures keeps your system clean and functional. Long-term organization is not a one-time task but an ongoing process that evolves with your needs.

Final thoughts on organizing Introduction To 3d Game Programming With DirectX 11

Effective organization, reliable offline access, and thoughtful use of interactive elements significantly enhance the value of digital Introduction To 3d Game Programming With DirectX 11. By implementing structured folders, consistent naming, cloud synchronization, and backup strategies, users can maintain a clean and accessible library. Interactive features further enrich the reading experience when used appropriately. Together, these practices ensure that Introduction To 3d Game Programming With DirectX 11 remains easy to manage, enjoyable to read, and highly effective as a long-term digital resource.