Cable Television Video-On-Demand for Learner-Centered Instruction: A Framework & Demonstration

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Introduction

The advent of Video-On-Demand (VOD) brought promises of rich video libraries, robust interactive lessons, and powerful tools for the curriculum developer. VOD has brought the excitement of a new media form, but with this excitement comes the confusion that accompanies any new field. This paper will discuss the nature of Videoon-Demand, and explore VOD's impact on education and curriculum development. We hope to clarify and accurately describe VOD and its marketplace to the educator.

Next we will show how VOD represents a robust and truly new medium for distance and interactive learning by starting with a review of Gagne's nine steps of instruction and then transposing theses methodologies onto the VOD space. Further, we will highlight elements of instructional design unique to VOD curriculum development and point out the power these elements pose.

We will continue by describing a generic VOD lesson plan, and then show the process by which a VOD lesson is programmed. Finally, we will walk through a completed VOD lesson finishing with a description of the future of VOD and its place in the arena of education.

Journey from Wasteland to Oasis

Americans devote more hours to watching television than to any other media - averaging 4 hours per person per day. TV is usually the center of the home and is on in the average house at least 7 hours every day (Nielsen Media Research, 2000). Forty-Five percent of all parents report using television to occupy their child (Kaiser Family Foundation, 2003). In the past 15 years Cable has transformed television from the nightmare of "The Vast Wasteland", to a 500 channel universe where viewers are more informed about the world while being entertained and educated on a variety of subjects from history to business, and from political science to forensic science.

Without any formal effort Cable has become the primary source of learning for tens of millions of Americans and hundreds of millions of people around the globe. Nearly 70 Million homes in the United States have Cable TV, and over 95% of the digital cable households will have access to VOD programming by 2008 (Paul Kagan & Associates. 2004). Information and education channels are the world's most watched cable channels: Discovery Channel is ranked #1 in cable networks with a subscriber rate of over 88 million, and nine of the top twenty cable networks are educational or informational (Kagan Research LLC, 2004).

Unlike broadcast or satellite television, Cable TV has "two-way" functionality built-in, and thus can become a truly personalized medium. The Telecommunications Act of 1996 allowed cable operators to invest vast sums of money into cable upgrades and technology systems, thereby expanding the frontiers of cable technology and allowing for intriguing new services. Since 1996, the cable industry has invested more than $85 billion to rebuild and upgrade its facilities, including $10.6 billion in 2003 alone (Witness testimony at the US government Subcommittee on Telecommunications and the Internet; Kevin Leddy, Sr. VP, Strategy and Development Time Warner Cable, May 19, 2004). These new cable technologies, particularly VOD, are giving instructors new tools for more effective instruction and new ways of reaching those who want to learn.

What is VOD?

Defining "Video-on-Demand" is often in the eye of the beholder. Experts and laymen often refer to VOD in a myriad of terms from "movies any time you want" to "streaming media". Sometimes VOD is merely defined as "the ability to pause and rewind TV shows without the need for VCR." These definitions are only partially accurate, and more often are misleading. For the purposes of this paper, we will define VOD by three elements:

1. Digital media.

Video must be prepared (encoded) into a digital format – e.g. MPEG-1, 2, and Windows Media. Digital video can be manipulated in such a way as to provide meaning and context. Since digital video is a medium prepared in discrete chunks, as opposed to analog media, digital video is easily recognized and processed by software.

2. Delivered over Broadband (Cable) Television

Cable-VOD is delivered without any delay and thus is not "streaming media". Streaming media typically has a series of "buffering" delays in delivery, usually there to overcome memory limitations in personal computers.

Second, VOD is viewed on a television set, and delivered via "set-top box". The television viewing experience is essential not only for video quality, but because of the mindset and behavior of the viewer/learner when sitting in front of a television versus a personal computer or any other learning experience, including with a live instructor.

Third, all media (video, audio, and graphics) originates remotely but are delivered in such a way the viewer is unaware as of their location of origin. They see it immediately or "on demand" (hence the term Video–on-Demand).

3. Incorporates software intelligence

Incoming media must have additional software added in the TV "set-top box" that helps the learner interact with the media. As a result the media changes and adapts depending on the viewer's response or behavior.

Misconceptions and Differences

When discussing VOD it should be noted that there are a number of misconceptions preventing many designers from accepting VOD as a valid educational tool.

1. Education on cable via VOD is not the same as "distance learning".

Receiving VOD does not necessarily require that there be "someone awake at the other end" to receive the information. Video-on-Demand can either be a passive experience, a background experience or a shared group experience with "no one at the wheel".

2. A keyboard is not essential for the initial educational experience.

Vast interactivity can be achieved using a conventional remote control, and frequently encourages more interaction due to the fact that the remote control is a simple device, requiring minimal dexterity.

3. VOD programs are not presented the same for all viewers.

Software intelligence that chooses and manipulates video can be combined with the cable operator's ability to store and recall user data, to create truly customizable programs tailored to the skill level and interest of the viewer.

New Technologies Make VOD A Powerful Force for Education

While VOD learning has facets in common with other media/multimedia learning systems such as DVD/CD-R, and Personal Computers, the following features, when combined with software intelligence, transform Cable-TV VOD into a unique and powerful new medium for learning and for teaching:

1. VOD has true interactivity

The ability for the learner to use their remote control in order to respond, real time, to questions posed by "the media" (an instructor depicted in the video, "talking" to the student, or simply a graphic "True/False" menu).

2. VOD has Branching

Branching is the ability to "jump" to different segments of the video – driven by viewer control, or behind the scenes, without the viewer being aware of the change in flow.

3. VOD has Intelligence

Based on viewer/learner responses, and based on the curriculum developer's (instructor's) design, the software can change what kind of video, graphics, audio or other information the viewer sees. In other words – the

software can learn about the learner – and present educational media that can guide the learner, become personalized, adapt and challenge the learner to become a highly effective educational experience.

4. VOD Capitalizes upon TV Viewing Behavior

People behave differently when in front of a television, and their expectations are different than almost any other medium. TV is a "persistent" and active medium: When TV is on it is always delivering content and changing every minute (as compared to a static computer screen). TV viewing behavior is much more dynamic than most realize. First, viewers are used to dividing their attention between different channels, often keeping track of several stories simultaneously. Second, though TV was originally a one-way, lean-back, storytelling medium it is now anything but a passive experience. Viewers anticipate shows and events, modify their behavior and lifestyle around scheduled airtimes of their favorite shows, patiently await the next episode, willing to be interrupted, and will dutifully return to the TV after the commercial break. They become passionate about the content and characters, and even more passionate about which channels and information they watch and trust.

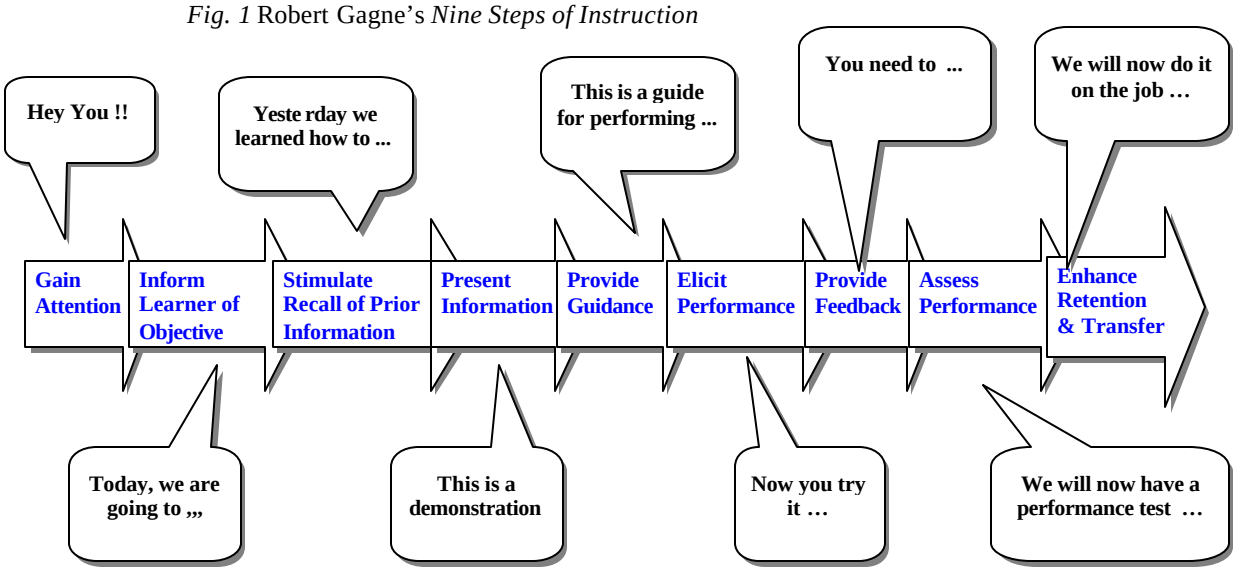
These behaviors, combined with VOD and software intelligence, create a unique new environment for learning and teaching. This VOD learning environment enables educators to:

- Create lessons available to broad audiences but automatically personalized and customized to each learner.
- Combine many different kinds of media video, audio, graphics, along with other modalities (kinetics – by using the remote control) to impact the learner in a highly personal and effective manner.
- Combine pre-defined course media, with personalized responses and pace.
- Combine pre-defined course media, with timely, real-time information (e.g.: VOD-Instructor to Student: "Use your remote control to identify 5 members of the President's cabinet on any of the news channels tonight").
- Reinforce in a variety of new and effective ways (e.g. for someone learning French, the lesson can, during a movie occasionally pop-up the French translation for a familiar line in the movie).
- Allow the student to take control and guide the educational journey on a path that suits her or his interest.

A framework for VOD as a teaching tool:

The work of Robert Gagne is particularly relevant to VOD instruction. In 1970, Gagne outlined 9 steps in the instructional process that applies well in today's new media, interactive age. Gagne stated that there are nine events that should occur to stimulate effective learning (Gagne, Robert M, 1970, The Conditions of Learning 2nd ed., New York; Holt, Rinehart and Winston.).

Fig. 1 Robert Gagne's *Nine Steps of Instruction*



1. Gain attention: Present a problem or a new situation. Use an "interest device" that grabs the learner's attention.

2. Inform learner of Objective: This allows the learner to organize her thoughts and around what she is about to see, hear, and/or do.

3. Stimulate recall of prior knowledge. This allows the learner to build on her previous knowledge or skills.

4. Present the material. Impart the information in manageable portions in order to avoid memory overload. Blend the information to aid in information recall.

5. Provide guidance for learning. This is not the presentation of content, but the instructions on how to learn. Usually this is more straight-forward than the actual subject matter or content.

6. Elicit performance. Practice by letting the learner do something with the newly acquired behavior, skills, or knowledge.

7. Provide feedback. Show correctness of the learner's response, analyze learner's behavior. This can be a test, quiz, or verbal comments. The feedback needs to be specific, not, "you are doing a good job." Tell her "why" she is doing a good job or provide specific guidance.

8. Assess performance. Test to determine if the lesson has been learned. Can also give general progress information

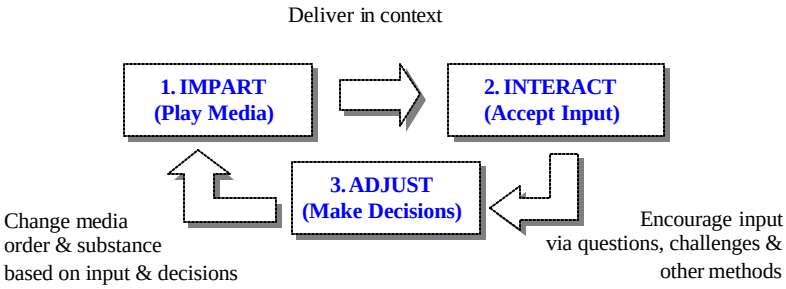
9. Enhance retention and transfer. Inform the learner about similar problem situations, provide additional practice, put the learner in a transfer situation, and review the lesson.

Instructional concepts specific to VOD

How and where do VOD techniques fit into instructional methodolgies? On an abstracted level, VOD instruction is straight-forward, and consists of 3 elements: Impart-Interact-Adjust.

1. Impart: Media is delivered to the learner in context (at the right time and place).
2. Interact: Learner input is solicited via questions, menus and other methods.
3. Adjust: Software intelligence decides how best to proceed with the lesson based on what it observes about the learner and based on the way the instructor wants to proceed.

Fig. 2 Basic VOD Instructional Unit



It is important to note that VOD, along with related control software, is essentially independent of the subject matter or content of the media. Instructional video is displayed to the viewer and manipulated by VOD, but for the purposes of this discussion VOD does not create the video or graphical instructional materials.

Guided vs Self-Paced

Depending on the "script", the learner can be guided through the lesson in a manner pre-determined by the instructor, or the learner can take control and embark on a completely "self paced" lesson. Between these two extremes, there is a powerful mode where the pace, level and subject matter of the guided instruction changes depending on what the instructor learns from the student. Based on feedback from the learner (number of incorrect answers, slow responses, frequent repetition of information), the order, pace, and content of the lesson can change in order to better teach the student.

Teach and Assess

The simple "impart-interact-adjust" model can be used as part of a broader abstraction to elicit two major instructional mechanisms: Teach and Assess.

Fig. 3 Guided Vs. Self-Paced Instruction

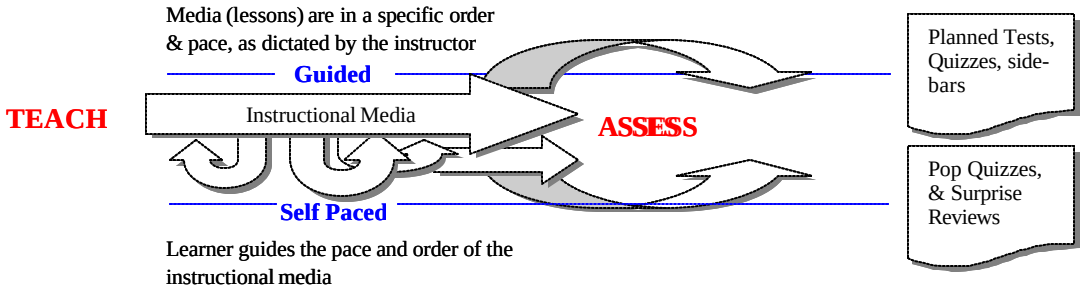


Table 1 – *Teach & Assess*

TEACH		ASSESS	
Imparting of pure instructional media (information, lessons, examples etc).		Determining the learner's progress through various challenges (tests) and other methods of determining how well they met the learning objectives.	
Guided	**Self-Paced**	**Guided**	**Self-Paced**
Video, Audio and Graphics are delivered in an order and pace predetermined by the instructor	Learner controls the pace and order of the information	Planned tests, quizzes and other challenges are dictated by the instructor	Learner determines when he/she is ready to test, can self-test and review.
"Adjusted" Based on interaction and feedback from the learner, the pace, flow, content and context of the information changes and adjusts to the level of the learner.		**"Adjusted"** Based on interaction and feedback from the learner, questions or challenges are changed dynamically in a way that focuses on the learner's objectives, or weak points.	

Anatomy of a VOD Lesson

Each basic "impart-interact-adjust" VOD element can be used and re-used to create meaningful instructional modules that can be combined – either during curriculum development-time, or real-time – to create a robust framework for instruction.

Fig. 4 Anatomy of A VOD Lesson

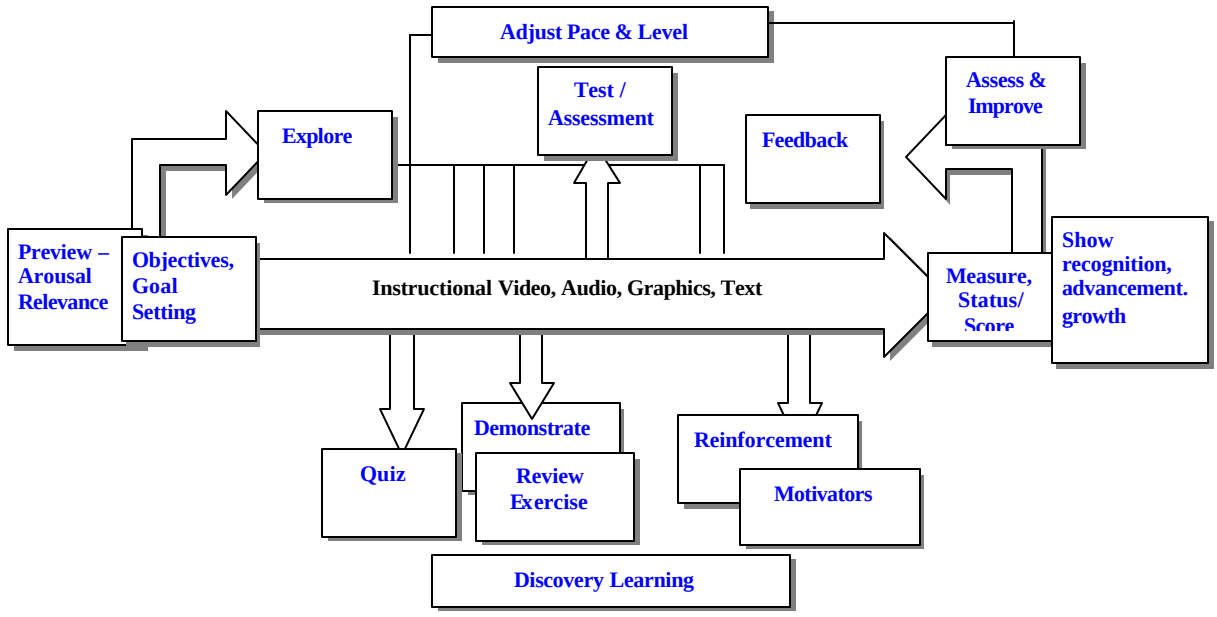


Figure 4 and accompanying Table 2 detail various VOD learning modules (each constructed of a portion of the simple "impart-interact-adjust" module). These modules parallel the instructional elements outlined by Gagne's Nine Steps. Together they form an almost comprehensive framework for instructing and learning using VOD.

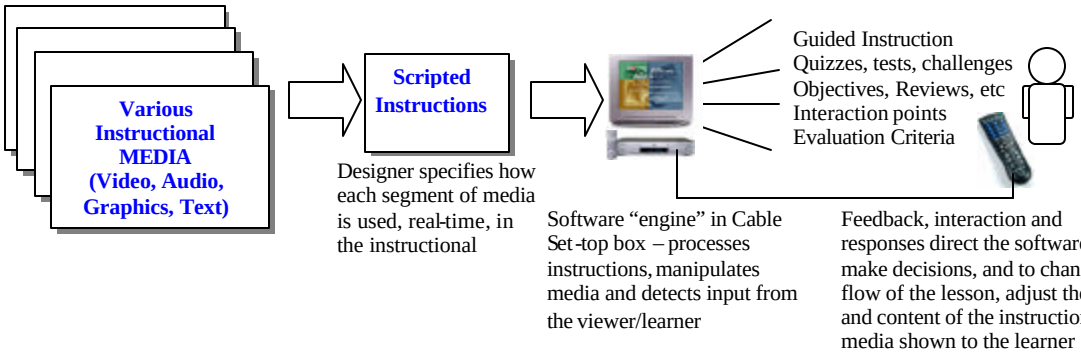
Table 2 *VOD Techniques vs. Gagne's Nine Steps of Instruction*

VOD Module	VOD Behavior	Gagne Step
Preview, Arousal, Relevance	Shows segments of the entire lesson up-front to inform and heighten interest.	**1 Gain attention**
Objectives, Goal Setting	Spells out the learning objectives via on-screen graphics – allows for direct and immediate investigation of the subjects.	**2. Inform learner of objectives**
Review	Automatically present summary of prior segments. Remembers the learner's level and reviews to the point of the last learning session.	**3. Stimulate recall of prior info**
Instructional	Straight-forward playing of instructional video, with timed, in-context, graphics and text information.	**4. Present the info**
Sidebars, Examples	In-context guidance (video, text), based on detection of learner level of proficiency.	**5. Provide guidance for learning**
Quiz, Challenges, Exercises	Pop-quizzes, questions and other on-screen mechanisms that challenge the learner to respond with answers.	**6. Elicit performance**
Feedback	Frequent on-screen information as to how quickly the learner is progressing, or how accurate learning is thus far (based on quizzes).	**7. Provide feedback**
Test, Assessment	Presents the learner with a series of questions in a variety of media and formats, in order to gauge how much of the lesson was learned. Assesses level based on score, response time and other metrics.	**8. Assess performance**
Reinforcement	Media imparted with simple or sophisticated rules to provide variety, randomness, and context - via demonstrations, motivational segments and "linked" segments.	**9. Enhance retention & transfer**

VOD Implementation of Learner-Centered Instruction

Next, we move from concept to design, then to implementation: How do we design lessons using VOD modules, and how are these modules actually implemented? First, we need a system where we can "feed in" media, and process instruction-oriented commands that transform the media into a lesson. This system must deliver the media seamlessly to the learner, accept input (interaction, responses) and then change the mix and flow of the media accordingly. The curriculum developer must have a simple framework for specifying what information will be imparted to the learner, and how the lesson will change based on the learner's interaction.

Fig. 5 Real-Time Delivery of VOD Instructional **Media**



Software technology by Chaos Media Networks is designed to allow the curriculum developer to specify the VOD learning modules, the related media and decision-making rules. These rules are executed "real-time" and the learning media experience is created as per the designer's intentions while the learner/viewer is watching TV.

Preparation Steps for VOD Curriculum Design

Educational VOD still relies on solid planning and curriculum design practices. Planning and preparation are as powerful as the new delivery mechanism enabled by VOD. Below are the planning steps:

1. Identify the instructional content. Gather video, audio or graphics to be used for the raw instructional assets.
2. Determine the flow of media. Decide the general order in which media assets should appear in the lesson.
3. Determine points of participation, interaction or control: Where learners can deviate from the planned lesson flow.
4. Determine the challenges: Quizzes, tests etc.
5. Determine proficiency / difficulty levels: Decide which media is appropriate for different competency levels.
6. Decide assessment levels: i.e. decide how to assess the level of learning (scores, speed, etc.)
7. Identify and provide various areas of feedback, reinforcement, motivation, demonstration - in the form of in-context sidebars, games, challenges and other techniques.

Authoring for Real-Time Use

Intelligence provided by the Chaos VOD software engine allows the curriculum developer to list out the VOD teaching modules outlined earlier (Figure 4, Table 2). These commands are listed in tabular form, in a spreadsheet, purely for the convenience of the designer.

Table 3 – *VOD Scripting Commands*

Scripting Module Command	What happens
Instruct	Plays media* in a specific predetermined order without interruption.
Guided	Same as "instruct" but allows the learner to control the speed of the instruction and jump around to specific segments via a menu designed to guide them back to the proper segments.
Objectives	A graphical display of the goals of the particular section, which can be adjusted based on the progress of the learner.
Explore	Allows the learner to take control of a particular section and view the media without interruption or guidance from the system.
Quiz, Pop-Quiz	Within a particular guided/instruct segment, a random, in-context quiz is made to appear – challenging and assessing the learner's progress. Quizzes take on a variety of modes from simple multiple choice, to more complex game-like challenges.
Test	Specifies a series of questions at the end of a section in order assess a score.
Adjust	Allows any subsequent media and assessments to change based on responses from the learner (score, speed, completion of sections).
Other	Several other commands: Reinforce, motivate, remind, review, demo, sidebar, think ("think about it"), assignment are all different methods of imparting instructional media in-context, and in a variety of different visual delivery modes in order to make learning more effective.
Status, Progress	Allows the designer to query and/or display the learner's status (completed segments, correct answers, speed, duration).

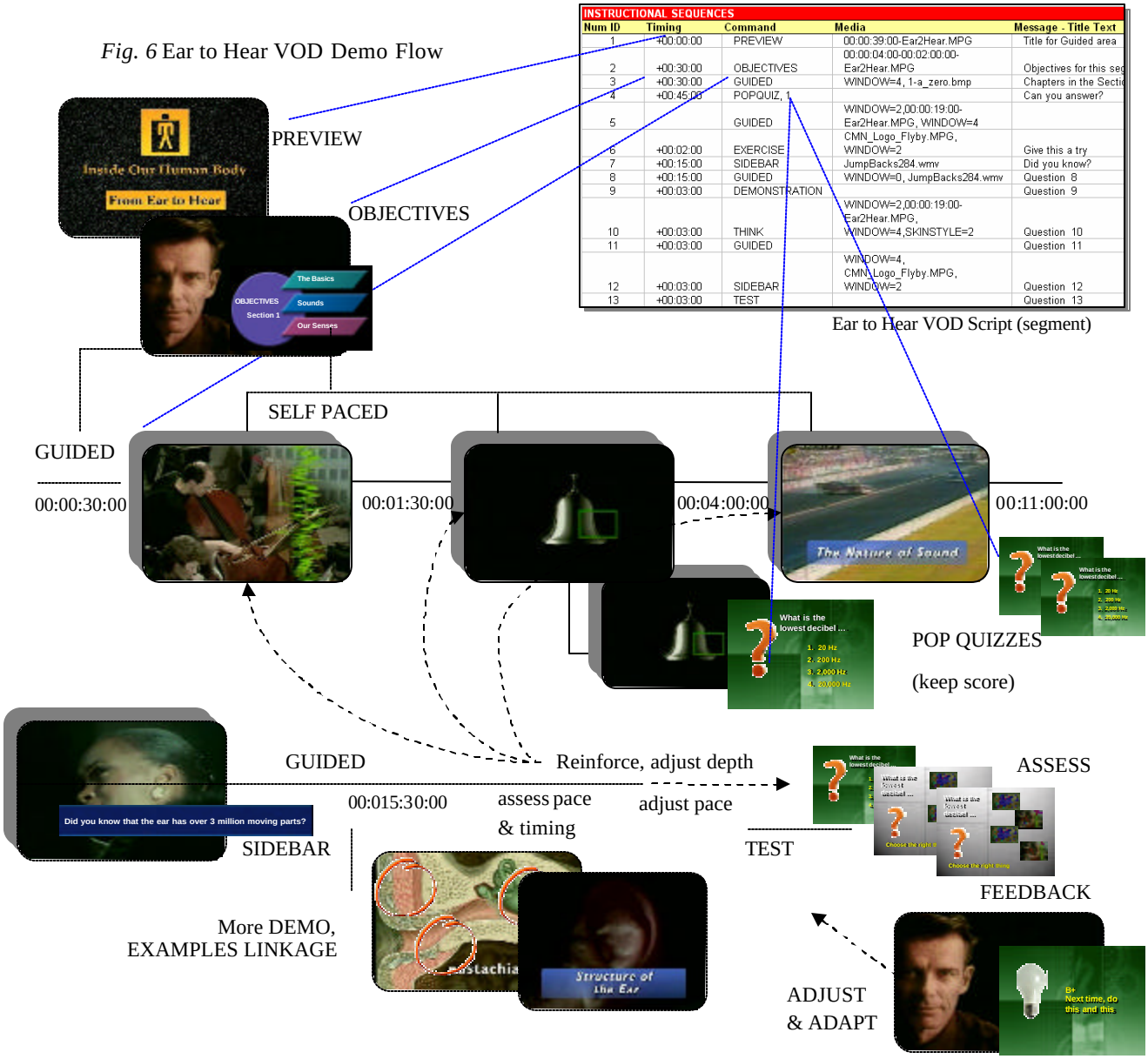
* Media = Any combination of video, audio, graphics or text.

A Sample Instructional VOD Design and Session

For purposes of demonstration, we used a video from the Agency for Instructional Technology: "Inside Our Body: From Ear to Hear" (AIT, 1998). In this sample demonstration we use the following script …

1. PREVIEW the lesson, and start from where the learner left-off last.
2. OBJECTIVES – List objectives for the current segment.
3. GUIDED – Present the lesson, but allow the learner to explore at their own pace.
4. POP-QUIZ – at a specific time display a surprise-question to assess the learner's understanding.
5. SIDEBAR, THINK, DEMONSTRATE – show extra information and give opportunities for the learner to explore deeper or in more unusual directions before resuming the lesson.
6. GUIDED – Continue lesson, with more quizzes and sidebars.
7. ASSESS – determine progress by comparing pace and scores on quizzes.
8. ADJUST – Revisit specific sections in more depth, or accelerate pace based on assessments.
9. TEST – Formally assess the learner's understanding with a series of questions.
10. FEEDBACK – Display and explain results, review and give recommendations for future learning sessions.

Fig. 6 Ear to Hear VOD Demo Flow



Summary of VOD Demo Experience

Figure 6 illustrates (in an abridged format) how this session flows. Note that interactive VOD sessions are not "top-down" nor typically have a beginning, middle, and end. While instructor (designer) has loaded the knowledge and decided some of the flow and rules, it is the learner that is in charge, with the program/lesson reacting and adapting. If the learner is going slowly, the lesson spends more time in problem areas. If the learner answers questions correctly, the lesson picks up pace. If the learner simply wants to indulge their curiosity and explore – they can spend time on that too. And if the learner has a specific objective, perhaps only this one time, they can specifically direct the lesson to focus on this objective.

The technology is designed so that the scripting commands are abstract and modular, so the designer can focus on the flow and the media, as opposed to technology. The scripting technology/framework is designed so that the modules "reuse" themselves, and also displays media in a variety of random formats in order to always give the learner a fresh and engaging experience.

Conclusions / Recommendations

Video-on-Demand over Cable is a new and powerful medium for teaching and learning. It combines non-linear video and software intelligence with the unique viewing behaviors of television. Interactive Video-on-Demand spawns many new design concepts that dovetail very easily with common instructional techniques. Using special software that enables both the design and delivery of interactive VOD instruction, curriculum developers can now produce lessons and courseware that can reach broad audiences, while having each lesson be a highly personalized learning experience for the student.

The basic functional modules of VOD are simple: Impart-Interact-Adjust. When combined with a repository of raw instruction media, the combinations are endless. When designing for VOD instruction, the rules and flow of the lesson are as important as the actual instructional media. Video, audio, and graphic assets can be re-used and re-purposed to create seemingly original instructional products. These new instructional products adapt and personalize themselves real-time so they appear differently to each learner.

While curriculum developers might not need to know deep technology in order to script new VOD learning products they will need to think differently. Certainly the conceptual design process needs to focus on the 'non-linear', but also on using existing assets, and targeting many different types and levels of viewers, and adapting. It means designing in a 'behavior' and intelligence into the learning product that will know how to respond and adapt to different learners and different situations.

Within the next 3 years Video-on-Demand will be available in almost every cable TV household. Curriculum developers now have the opportunity, means and methods to tap into a $150 Billion home educational media market so far not possible over television. Also within the next 3 years, Cable television systems will allow additional functionality such as voice recognition, social networking, and two-way video – giving curriculum developers almost unlimited possibilities to reach and teach students.

After nearly 10 years and over $80 billion dollars in digital cable infrastructure development, the 'golden-spike' has finally been driven. The opportunity and possibilities have increased by several orders of magnitude almost overnight. Video-on-Demand over cable television is about to give curriculum development a new renaissance, and the time to start learning the VOD-specific concepts and techniques is right now.

Technology Grants and Rural Schools: The Power to Transform

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The requirements of No Child Left Behind Act of 2001 (NCLB) has presented challenges for schools and districts across the United States such as a new need to focus on test scores and student achievement. While all states, districts, and schools face challenges that require them to adjust the structure and delivery of instruction in their schools, the small population and geographic isolation of rural schools can make change even more challenging (Reeves, 2003). Some have suggested that one way some rural schools may be able to overcome these challenges is through an increase in the level of technology integration in their school (Collins & Dewees, 2001). Schools struggle not only to implement and integrate technology into their curriculum, but also struggle to find the funds that they can allocate to the purchase and maintenance of technologically-enhanced instructional strategies. Fortunately, the high cost of technology and the potential educational impact of technological resources have led to the awarding of federal and state grants to facilitate the implementation of educational technology in schools (Herr & Brooks, 2003). This study examines one school's attempt to use grant money to purchase and integrate specific instructional technology into their school in order to increase student achievement.

Rural Schools

Schools in rural areas or small towns make up nearly 42 percent of all schools in the United States and represent 30 percent of students in the country (U.S. Department of Education, 2002). A rural school is defined as a school in a community whose population is less than 25,000 people (Mathis, 2003). These schools face many challenges due to their unique characteristics including: geographic isolation, declining enrollment, small population, limited funding, and lack of access to services (Reeves, 2003). Further compounding the challenge is the frequent use of funding formulas that allocate funds to districts on a per-pupil basis. These formulas are often used by federal and state agencies to distribute money to schools and puts rural schools at a disadvantage as they attempt to supplement their budgets (Hadderman, 1999). The availability of funding for rural schools often impacts their ability to access programs, services, and training opportunities, and plays a role in their inability to build capacity to comply with the standards set forth in the NCLB Act (Reeves, 2003).

Technology and Teacher Attitude

Teacher attitudes toward technology influence the level of technology integration in schools. According to the National Center for Educational Statistics (NCES), less than 20% of teachers reported feeling very well prepared to use technology in their classroom instruction (USDE, 2002). Training teachers to integrate technology is another way rural schools can invest educational technology. Once rural schools have successfully recruited "highly qualified" teachers and provided them with technology, schools must provide ongoing training in technology as well as administrative support in order to facilitate successful implementation of technology-facilitated instruction (Wang, Johnson, & Pisapia, 1994). Heath et al. suggest two factors that influence teacher attitude change toward technology integration are (1) having a willingness to change, and (2) the control structure of the school environment. Allowing teachers to see the potential benefits of technology for themselves and their students may help facilitate an attitude of willingness to change. Additionally, maintaining a power structure in the school that allows teachers the freedom to move from one stage of technology integration to the next in a supportive and non-dictatorial manner allows teachers to feel empowered to introduce technology into their instruction. Heath et al. (2000) also found that professional development and training in technology enabled many teachers to integrate technology effectively. Providing opportunities for exposure and development of positive teacher attitudes toward technology, is the beginning of the change process as schools try to move toward technologically integrated instruction.

The nature of rural schooling, teacher attitudes toward technology, and the utility of technology to impact teachers' instruction, are all factors that must be considered as schools look to provide an education for students that optimizes learning opportunities and provides cost-effective instruction. The potential impact of technology to