It is not television anymore:

Designing digital video for learning and assessment

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To Appear in Video Research in the Learning Sciences; R. Goldman, S. Derry, R. Pea, & B. Barron (Eds.). Mahwah, NJ: Erlbaum.

When used effectively, video is a powerful technology for learning. Researchers can examine videotapes to learn about patterns of classroom interaction. In-service teachers can review videos of their own teaching to reveal their strengths and weaknesses as instructors. In these instances, the video captures naturally occurring events that often elude the naked eye when seen in person but become clearer upon review. In this chapter, we consider a different use of video for learning. We describe the use of *designed* video, where the author of a video decides on its components and features beforehand. For example, take the case of a scripted video of a child incorrectly solving a math problem. A researcher can ask other children to watch the video and comment on the errors they notice. When used this way, the video is designed as an assessment that helps researchers learn what the children know. Designed video can also help students learn. For example, a professor might use the same video clip to help explain common mathematical errors to an entire class. Designed video can support learning in many ways. In this chapter, we provide a simple framework for mapping uses of video into desired and observable learning outcomes. We then show how this framework can be applied when designing video embedded in multimedia environments.

In the not-too-distant past, videos for learning were often under-budgeted, highly didactic efforts with laughable production values. How could they compete with prime time? Advances in technology, however, have made it so that designed video is no longer in the sole province of broadcast television or dependent upon a full-fledged production studio. At a public high school that we frequent, students produce daily newscasts with digital camcorders. What the segments lack in high-end production, they make up in immediacy and prove that effective applications of video are within reach.

As instructors of courses on learning technology, we ask students to produce instructional videos. Within two weeks, relative novices produce learning-relevant videos with more visual appeal and information than they could prepare given months of computer programming. Yet, despite the ease of camera use, the array of editing features, and the many video genres, we find it frustrating that the literature provides few resources that can help these students make even more effective use of video for learning. Excepting work on mass media (e.g., Fisherkeller, 2002), there are relatively few empirical evaluations on the use of video for learning, even when compared to computer-aided efforts, as suggested in Table 1. There are also few practical publications to help design video for learning (for an exception, see Seels, Fullerton, Berry, & Horn, 2004).

Table 1. Percentage of journal abstracts that indicate research on video-aided or computer-aided instruction, as found in the ten issues prior to October 2005. Each journal has a strong peer-review system and accepts articles on learning interventions, at all ages, and on all topics.

Journal Title (number of abstracts)	Video-Aided Learning	Computer-Aided Learning
Cognition and Instruction (n=31)	3.2%	25.8%
Educational Technology Research and Development (n=56)	3.6%	57.1%
Journal of Educational Psychology (n=159)	2.5%	9.4%
Journal of the Learning Sciences (n=31)	9.7%	61.3%
Learning and Instruction (n=48)	6.3%	16.6%

Our frustration with the available literature has led us to write this chapter on designed video. We offer some suggestions for educational researchers and instructional designers alike. Within the field of the learning sciences, most practitioners fill both roles – they design activities for student learning, and they assess the effects of those activities so they can learn what works. Thus, in the following discussion we consider applications of designed video for both instruction and assessment. To help organize our suggestions, particularly for beginners in the learning sciences, we present a framework for matching different genres of video with different types of learning. It would be a mistake on our part to delineate the many different genres of video, but then treat learning as a single thing. There are many types of learning, and different applications of video are more or less appropriate for each. To design an effective video, it is important to have a clear target, so in our discussion, we describe some important findings about learning and how to promote and measure it.

In the first section, we describe common learning outcomes, give examples of video genres that achieve those outcomes, and suggest methods for determining whether an outcome has been achieved. We do not provide technical details for creating videos. Instead, our goal is to help people consider the relation between video and learning. In particular, we suggest a number of ways to help assess learning (with and without using video), because our experience has been that creating learning assessments is very difficult, until one has seen many, many different examples.

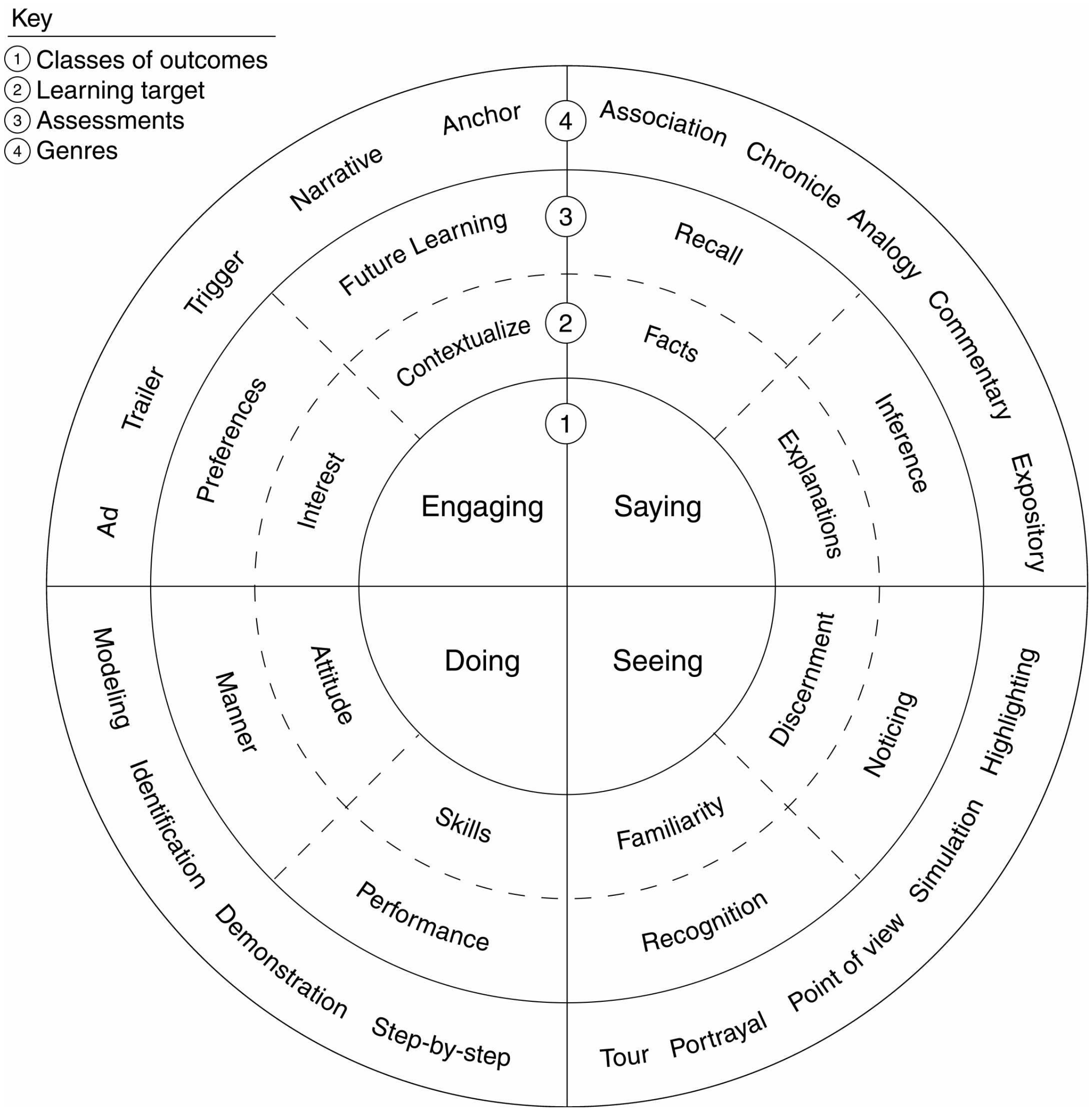
In the second section, we offer some examples of how one might use digital video in a larger, multimedia context. Video does not have to be stand-alone, like a TV program. Video is a more forgiving and powerful learning medium when it is embedded within a larger context of use. Thinking of a larger context is particularly useful for repurposing the raw footage that is frequently collected by researchers. This footage rarely makes a self-contained video story, but when embedded within a multimedia environment, it can be used in many creative ways to encourage learning interactions.

Four Common Learning Outcomes

A significant challenge for any designer of learning involves deciding exactly what people are supposed to learn. This decision requires more than choosing a topic to teach. It also requires a consideration of how the subject matter will be used. Take the example of asking an American to learn the sport of cricket. Is the goal that the person will be able to (a) play; (b) explain the history of the game; (c) recognize a good play; or, (d) want to learn more? Getting clear on the learning outcome is important, because one would probably use video differently for each outcome.

Figure 1 provides a map of different learning outcomes that will guide our discussion. The center shows four broad classes of learning outcomes. The first ring refines each learning outcome into approaches one might take to achieve the learning outcome. For example, one might promote the outcome of being able to “say” by providing people with facts or explanations. The next ring indicates the types of behaviors people will exhibit if they have learned. We will describe these behaviors in some detail, because they can help clarify the meaning of the learning outcomes, plus they provide the keys to successful assessments. Finally, the outer ring samples some relevant video genres for each outcome. We now take up each wedge of the learning pie in turn.

Figure 1. A space of learning for the use of designed video. The circular design of the figure pays homage to the instructional technologist, A. J. Romiszowski (1981).



Seeing

A signature quality of video is that it can help people see things they could not see before. There is a continuum of seeing outcomes. On one end is a *familiarity* approach that introduces people to phenomena they are unlikely to have seen – a strange animal, an industrial process, a foreign land. The familiarity approach counts on people recognizing what is novel. At the other end is a *discernment* approach that helps people perceive details they might otherwise overlook – the balance point of a painting or the difference between a 5.6 and a 5.8 in a gymnastic routine. The discernment approach presupposes that novices may not see what is significant even though it is “in plain sight.” To help people develop an “enlightened eye” (Eisner, 1998), it is necessary to educate their perception, because people tend to assimilate what is familiar rather than accommodate to new subtleties. Therefore, learning to discern often requires special provisions to help people notice (Sherin, this volume).

A common genre for exposing people to unfamiliar sights might be labeled *tour* videos. These include travelogues, nature shows, historical re-creations, and the like. They can include commentary to give a name and background to what is shown. There are also *portrayals,* as in the case of period pieces, where the novelty is woven into the dramatic narrative and setting. Moving towards the discernment side of the continuum, there are *point of view* videos that use camera angles, audio commentary, or interviews to give insight into new ways of seeing, for example, from the point of view of a character, a coach, or a hunted prey. Extreme points of view can create *simulated* experiences, as in the cases of video from the helmet of a skydiver or a highly empathetic character portrayal. Each of these approaches helps expose people to unfamiliar sights and perspectives. For the goal of helping people discern subtlety in the familiar, *highlighting* techniques are appropriate (Goodwin, 1994). Sport broadcasting has a sophisticated toolkit that contains instant replay, slow motion, zooming, and digital pens that commentators employ to highlight patterns of movement. Several chapters in this volume (e.g., Pea) describe digital video environments that help researchers notice and annotate. These environments can be re-purposed to support specific instructional goals, such as noticing aspects of one's performance that are difficult to observe in real time.

Given the range of seeing outcomes and possible video techniques, how can designers know whether their video has been successful? A *recognition* paradigm is the least demanding way to test for familiarity. One might show pictures or video clips and ask people to select the ones they recognize. People, however, are very good at recognizing images (Shepard, 1967), so this can be made a more sensitive measure by showing things at a different angle or setting. It is not trivial to recognize a plant in the wild after seeing a video of the plant in a laboratory. For videos that target discernment, *noticing* assessments are appropriate. One form of assessment might take a forced-choice approach where people have to select which of two pictures or videos is exemplary. Pre-service teachers, for example, might watch two videos of teachers handling a student question and select which one shows the correct technique. A more open-ended approach provides the learner with a new video and has the learner describe what is important to notice about it. This is a difficult task because what is important is often buried in a hundred other details. In this case, people need to discern what is significant despite the surrounding "noise." In all cases, appropriate assessments of learners' abilities to see will require asking learners to look at something. Thus, video is not just useful for initial learning, it also useful as an assessment tool (Derry et al., 2005).

Engaging

Engagement may be characterized as the pull that brings people to a situation or topic and keeps them involved. Engagement creates the mental context that prepares people to learn. Video is superior at creating engagement and setting the stage for learning, even though the video itself may not contain the new information people are supposed to learn. Video can help people bring to bear relevant knowledge to raise interest and make sense of subsequent instruction. One approach to engagement is to develop the learners' *interest* so they are more likely to take steps to learn. For example, a video might show examples of the enjoyment or money people attain once they have learned. A useful distinction distinguishes extrinsic and intrinsic motivations to learn (Lepper & Greene, 1978). Extrinsic motivators or rewards are often irrelevant to the knowledge gained through learning (e.g., receiving money for good grades). Intrinsic motivators, or what we labeled interest, depend on the target content itself being engaging. Piquing people's curiosity or showing the relevance of a topic to their own lives would be canonical examples of raising intrinsic motivation or interest. A similar form of engagement is to *contextualize* the information in ways that make it meaningful and relevant to the learners. One technique is to provide background information or activate prior knowledge that anchors the meaning of subsequent activities. For example, a video biography of an artist and her times can help students make more sense of a subsequent painting. Without relevant prior knowledge, people can have difficulty making sense of a lesson and often have no recourse but to memorize the content rather than understand it.

A familiar way to raise interest is through *advertisements.* Car and beer commercials use visual narratives of a desirable lifestyle. These advertisements have large production budgets, and thus, are out of reach for most designers. However, we recall a conversation with a venture capitalist whose hero creates cheesy infomercials to sell appliances, "He can sell anything!" Evidently, production values need not be a stumbling block to persuasion. *Trailers*, like a tourist video or movie preview, are similar to advertisements but tend to sample the content of what is to come more realistically.

Educational video often uses trailers by painting an initial picture of a domain (e.g., life in the sea) in preparation for a subsequent unit (e.g., on ocean ecosystems). Another method of engagement uses video as a *trigger* to set the stage for subsequent discussion. For example, television news magazines will often present an initial report to which experts and a call-in audience can react. Similarly, in a classroom, one might present a case study or example that is intended to stir discussion and raise a host of relevant issues and tacit beliefs. *Anchor* videos can be used to contextualize learning and problem solving. For example, The Adventures of Jasper Woodbury comprise 20 minute video narratives that contextualize multi-step mathematical problem solving (Cognition and Technology Group at Vanderbilt, 1997). The narrative includes a challenge (e.g., students need to plan how to save a wounded eagle in the video) and the information needed to solve the challenge (e.g., the relevant distances to safety and the speeds of different vehicles). The goal is for students to learn to solve complex mathematical problems. The contextualization of the video makes it possible to present a problem with a level of complexity that is hard to match with a word problem. The video makes the complex problem tractable by using a vignette that is easy to grasp and engages students' everyday knowledge.

Assessments of engagement should ideally target how well students are intellectually or motivationally prepared to learn. For interest, one can assess people's *preferences* towards learning relevant behaviors. For example, do students exhibit enough interest that they spontaneously choose further investigation and conversation over another option, such as going outside and playing? One might also populate a database or web pages with information and record if students access those pages associated with the video. For contextualization, one might measure *future learning* from subsequent instruction (Bransford & Schwartz, 1999). For example, one might compare students who did and did not watch a biography of an artist. Afterwards, both groups of students receive a subsequent lesson on a relevant painting. Ideally, students who watched the biography would learn more or different things from the lesson on the painting. So, rather than directly measuring what people learn from the video, one can measure what people learn from the lessons following the video, on the assumption the learners can engage the new materials more fully.

Doing

Video is ideal for presenting human behaviors. There are two quite different sub-classes of "doing outcomes" – those involving *attitude* and those involving *skills*. For attitudes, people readily learn by modeling other people's behaviors (Bandura, 1986). People can model other people so well that learning can be unintentional, which is one reason that violence on television is of concern. The second outcome is skill acquisition and typically involves intentional effort and practice on the learner's part. The number of skills, or procedural knowledge, an adult possesses is hard to fathom – brushing teeth, riding a bike, taking conversational turns, computing best buys, and so on. As with attitudes, people can learn skills by imitating behaviors shown in a video. Sometimes skills are quite complex so that replaying, zooming, and slowing the motion can be quite helpful. Other times, when it is too much to expect a learner to imitate an expert's fully integrated performance, it makes sense to decompose a task into sub-skills that are learned separately. Additionally, for some skills it is important to help people see the critical components of the behavior. For example, novice tennis players may not see the key moves of the professional, in which case, they cannot possibly imitate it. Good procedural instruction makes sure that students can discern the behaviors of significance so they can imitate them. In this case, to achieve the outcome of *doing*, one also needs to target the outcome of *seeing*.

Video models can help to shape attitudes. The young children's program, Mr. Rogers, modeled politeness on the assumption that children would be polite. Another way to invoke attitudinal learning uses *identification*. Effective drama causes people to emulate a hero, and teens are well-known for their identification with media stars. Simple *demonstrations* are a useful way to help people learn skills. Cooking and home repair shows are familiar examples. There are also training videos for learning sports and mathematical procedures, where experts perform the task in a rather slow fashion (for them). When tasks get complex, videos often use *step-by-step* instruction that breaks a task into manageable chunks. It should be noted that the best skill instruction also includes a narrative that explains why a particular procedure takes the form it does. Without an explanatory overlay, people can learn a skill, but they may not have any flexibility when performing it. For example, if people merely imitated the behavior of pulling the parking-break lever without understanding why, they would be in trouble with a car that uses a floor pedal instead. Examples of children blindly copying mathematical procedures without understanding are legion, as are the consequences.

Ideally, "doing" evaluations require people to perform some action, rather than just say what they would do. For attitudes, assessments evaluate the learner's *manner* in context. For example, researchers can study if portrayals of violence affect children. Do young children exhibit a more aggressive manner after watching video violence, for example, by walking over the legs of children sitting on the ground instead of walking around them? This evaluation is notable, in part, because it looks for a proximal effect (immediate behavior) rather than the distal effect that people really care about (violent behaviors in later years). Though this is not completely satisfying, it is wise advice to first look for proximal outcomes. For example, after a video on sharing, one might put a learner in a relevant situation and see what happens. This is much easier than seeing if the children use sharing in their everyday habitats or waiting to see if children become adults who share. For skill acquisition, *performance* assessments are ideal, because they directly test the relevant behavior. There are various genres of performance assessment. For routine skills that require efficiency (e.g., driving a car), it makes sense to require full-blown performance (e.g., a driving test) and evaluate the number of errors and time to execute the skills. These types of assessments can be made more revealing by throwing in variations the student has not fully practiced (e.g., parallel parking on a hill). For less mature skills, one might ask people to perform sub-components of a task, which has the advantage of identifying what skill components require additional attention. Additionally, one can scaffold a performance for a novice by providing hints or supports to make the task easier. For example, with intellectual skills, like doing a science investigation, it is useful to create a set of supportive materials a novice can use, rather than just asking the learner to do an investigation cold. One interesting way to turn scaffolding itself into a dynamic assessment is to evaluate how many hints people need to complete a task (Feuerstein, 1979). For example, how many times does a student ask to review a video when trying to execute an assembly procedure shown on the video? Unfortunately, performance assessments can be impractical. In a sex education class, it might be best to simply ask students to recall the correct steps for safe sex. Of course, this does not mean students will execute the performance when the time comes. Talking the talk is not as good a measure as walking the walk, but sometimes, it is an acceptable proxy that can evaluate whether a video is moving people in the desired direction.

Saying

While the other outcomes tap into the unique strengths of visual media, "saying" outcomes – verbal or "declarative" knowledge – can be achieved by many media. Nevertheless, video is also good in this realm. One type of verbal outcome is the acquisition of *facts.* Facts include things like the name of an animal, the average temperature of the sun, 2+2=4, and so on. Facts are often seen as the stuff of memorization, but the difference between a good and bad news report is often whether it includes critical facts to help viewers draw their own inferences. Despite common belief, repetition is not the best way to learn facts. Repeatedly sub-vocalizing a phone number (e.g., 451–9180) is less effective than making up a formula with the numbers (e.g., 4+5 x 1 = 9 = 1+8+0). Bransford, Franks, Vye, and Sherwood (1989) demonstrated that people remember facts better when those facts come as a solution to a problem an individual has attempted rather than as a bald assertion. *Explanation* is a second class of verbal knowledge. Explanations, like those provided in good science shows, provide the 'why' and 'how.' They tie the facts together. A challenge for any video designer is estimating how far to move from facts to explanations. For example, a weather report might present the day's high temperature; it might explain the winds that cause the temperature; or, it might develop the science behind atmospheric phenomena. The further one moves from facts, the more important it becomes to create videos that make processes and explanations transparent; talking heads only work if viewers already have sufficient prior knowledge to understand what gets said (Schwartz & Bransford, 1998).

A number of genres emphasize retaining factual knowledge. Quiz shows are a bad example, because they typically do not help viewers remember. A better example is Sesame Street, which uses *association* to pair entertaining images and names to help children memorize the letters and numerals. *Chronicles*, like news broadcasts and narratives, deliver facts embedded within the context of a larger story. Moving towards explicit explanation, video can use *analogy* to help people understand; for example, the trade winds are like rivers in an ocean of air. Typically, single analogies (and examples) are not nearly as effective as pairs of analogies in helping people cull the deep explanatory structure (people tend to focus on surface features of a single analogy or example, Gick & Holyoak, 1983). *Commentary* or interpretation is a powerful way to supplement video with verbal explanations, as is often the case with news magazines and sports broadcasts. *Expository* videos explicitly develop a sustained account of some set of facts, as in the case of the science show Nova or other documentaries.

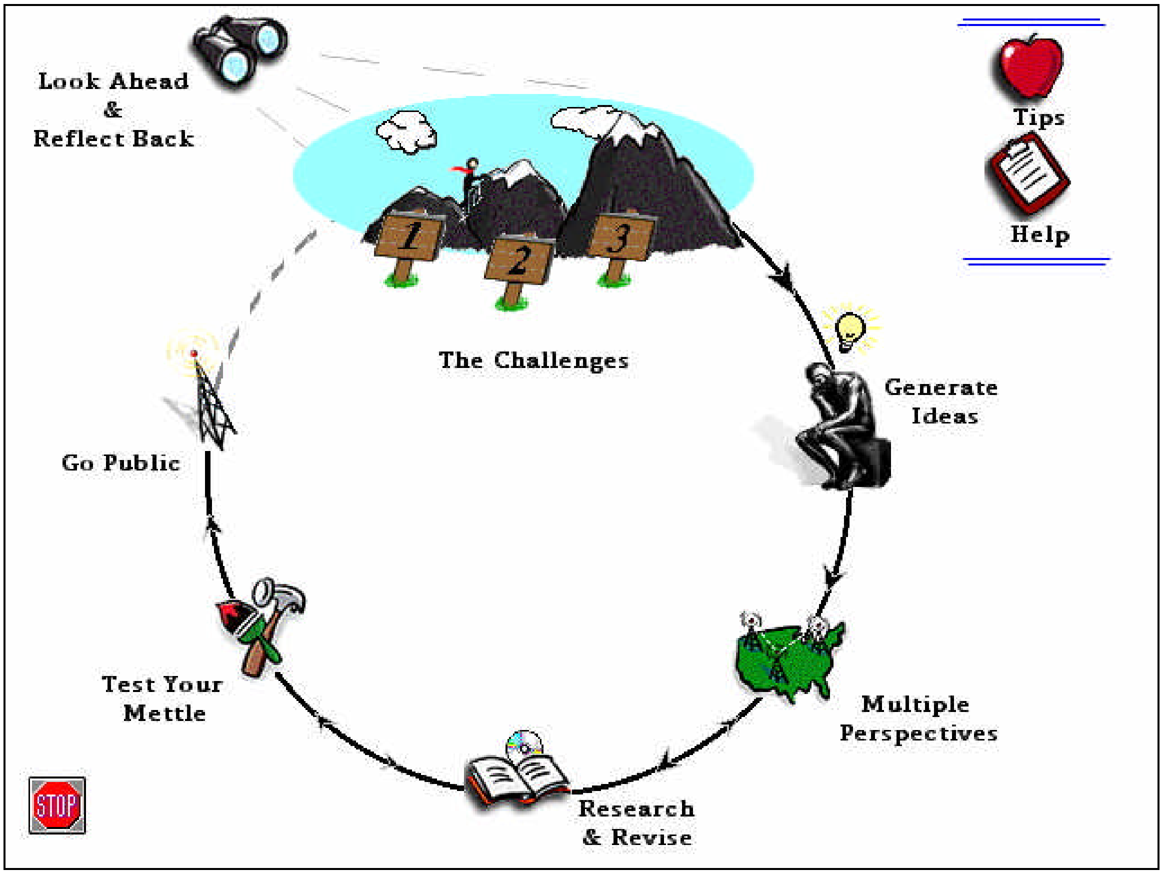
To assess factual knowledge, a *recall* paradigm is effective. This can take the form of free recall where people simply say or write what they remember. It can also take the form of cued recall, as in the case of showing a numeral and asking a child to state its name or say what numeral comes next. A demanding version of cued recall asks people what is missing, for example, from a classroom lesson plan or video demonstration. Multiple-choice tests, though a staple of educational testing, are problematic because students can get the right answer by guessing, especially if the test has obviously wrong "foils". For explanatory outcomes, the standard approach requires learners to draw *inferences*; students need to go beyond the information given to show they have not simply memorized the words. Inferences include things like problem solving, applying ideas in a new situation, predicting, taking up a point of view, and constructing an argument. Open-ended formats (e.g., essays, making a video) are more difficult to score than right/wrong problems, but they also provide more latitude for students to exhibit what they have learned. In general, explanatory knowledge is trickier than the other outcomes, because there are so many possible levels of explanation and understanding. More than the other outcomes, it is useful to think of explanation assessments before designing a video, because the assessments can help shape what is included in the video.

Putting Video in a Multimedia Context

The history of visual media comprises the invention of techniques and formal features that guide people's thoughts to particular outcomes. The zoom mimics attention; the slow motion in Raging Bull emphasizes the poignancy of critical moments of life. Rembrandt's self-portraits are exceptionally sharp around the eyes to reflect where he is looking. Multimedia, however, is relatively new. There are fewer established techniques, and it is useful to capitalize on extant formal features. At the same time, it means the potential for innovation and exploration is extremely high. Below, we offer a sample of a single multimedia program that uses video in a variety of ways.

The examples come from work with undergraduate, pre-service teachers in an educational psychology course. The course used a multimedia authoring shell, called *STAR.Legacy*, that was designed to help teachers use their local resources to create pedagogically sound instruction (Schwartz, Brophy, Lin, & Bransford,1999). The main interface of the shell, shown in Figure 2, includes an explicit inquiry cycle to help teachers and students navigate through distinct phases of learning.

Figure 2. The main interface of a multimedia shell, STAR.Legacy, for using designed video within a larger inquiry cycle. Each icon is a clickable button that leads students (and authors) to sections that support different aspects of complex learning. Each STAR.Legacy is typically populated by different uses of video that are either seeded by the instructional designer or developed by the teacher and students themselves.

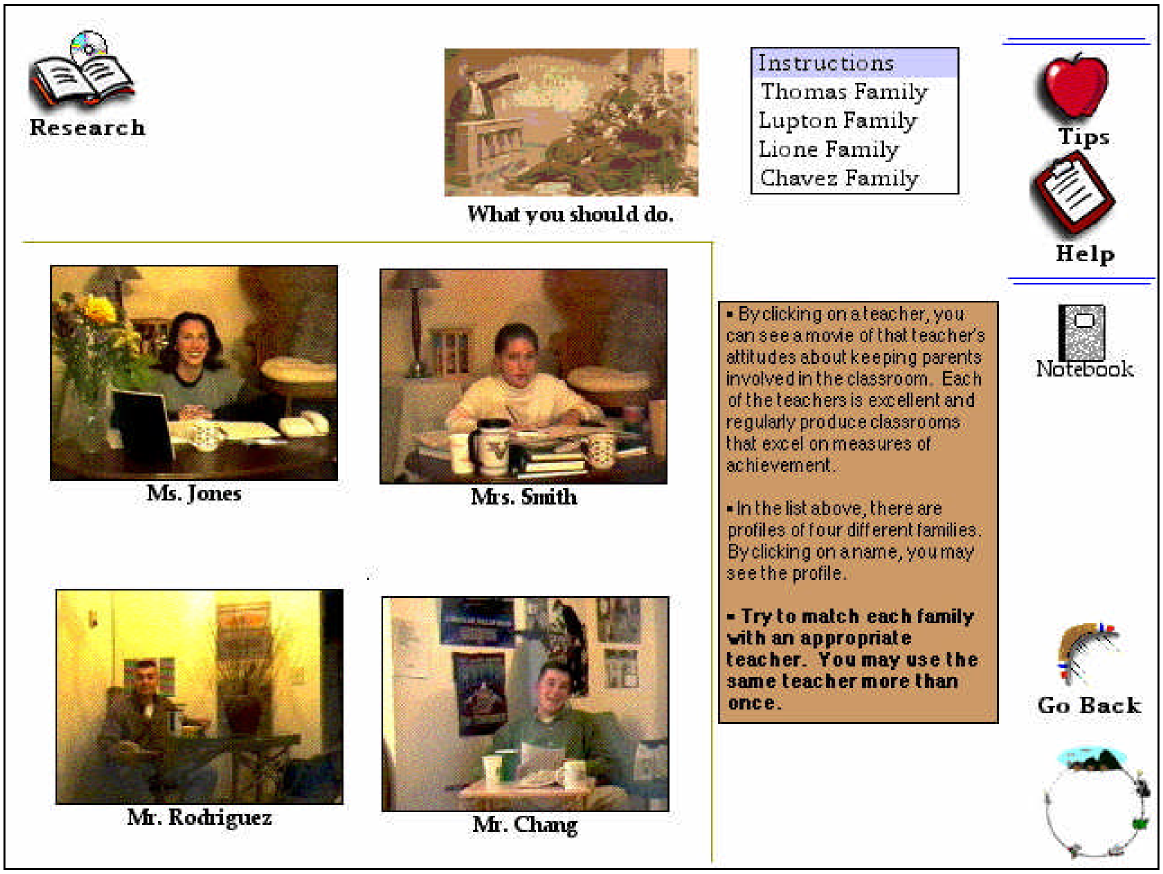


Typically, for any given inquiry topic, we populate the shell with initial videos and resources to seed the lesson. For example, each inquiry cycle begins with a challenge in the form of a trigger video to increase interest, contextualization, and discernment. For this Legacy, the trigger video was a recording of a local news segment on children building model rockets in “a mock mission to mars.” The trigger set the stage for the challenge of creating instructional resources to help teachers improve learning from project-based activities (see Barron et al., 1998 for ways to improve project-based learning). The pre-service teachers watched the news segment and then had to generate ideas about what they saw that was relevant to improving project-based learning. They typically noticed, in rather vague fashion, that the kids in the video were doing hands-on learning. After this, the students saw clips showing the multiple perspectives of six experts who had watched the same video. These videos helped students notice things they had missed, modeled an attitude of looking beneath the surface, and they provided short explanations. (We had shown the trigger to a variety of experts and videotaped them briefly as they described what they noticed.) One expert observed that the children were collaborating quite well, which means the teacher had done some activities on collaboration. Another expert observed that the children did not measure how high their rockets went, and therefore, they had no way to do science on their designs. The inquiry cycle then led the students to explore further resources (e.g., papers) and to test their mettle (self-assess what they had learned). Ultimately, they had to go public with what they had learned; they had to design a video-based lesson directly into the multi-media shell. Their task was to leave a “legacy” for future cohorts of students who would use the software. They found this engaging, and for us, it was a performance assessment of their ability to “do” multimedia instruction based on what they had learned about learning. In the following paragraphs, we describe some of the innovative ways they used video in a multimedia context. We separate their efforts by the primary class of outcome they targeted.

Seeing

Some of the students had read a paper on classroom practices. These students asked the author for the classroom video footage on which the paper was based. They cut the video into segments that mapped into each of the concepts in the paper and turned them into a “seeing” lesson. Next to each clip on the page was an audio button where the student designers had recorded explanations of the critical concept. Users had to indicate where in the video clip the concept was put in play. These students also included an assessment page; users saw new clips and had to determine which concept was exhibited in each clip. Another group of students used contrasting cases, like wines side-by-side, that can help novices notice key features (see Schwartz & Bransford, 1998). These students had read an article on how different parents appreciate different types of teachers. They directed videos of their friends acting out different teachers. As shown in Figure 3, users had to click on the juxtaposed video portrayals, notice the differences, and then match each teacher portrayal with the appropriate parents who were described in text fields to the side.

Figure 3. An example of video-based instruction authored into STAR.Legacy by pre-service teachers.



Engaging

One team of students created their video instruction based on an article about problem- and case-based approaches to education. They interviewed law students, lawyers, deans, and law professors about their experiences with case-based legal education. The students organized the brief video clips to reflect the different points of view of the stakeholders and how their attitudes towards case-based instruction changed with time. They included some simple audio with a button that explained how users should watch the video clips. The students' goal was to help contextualize case-based instruction to prepare learners to engage the associated article themselves.

Doing

Another team of students recreated a method of teaching simple mathematics using manipulatives. Users watched the demonstration video. Users then had to move simple images of manipulatives to set up instruction for a new problem. When done, the users could click to see the correct answer. Another group of students interested in collaborative learning, created videos about activities that help to make more cohesive groups. They showed an example of a group of students that followed the activities correctly next to an example of a group that had such divisiveness they could not complete the activities. This latter video showed how the teacher intervened to make the activity successful.

Saying

One team of students indicated that users should first read a target article on project-based learning. They then showed a video clip of some children working on a science project. The video stopped and the students had to predict what would happen next and give a justification for the prediction. They wanted students to draw inferences based on the explanation in the article. Afterwards, they showed videos of what different “experts” predicted would happen and their justifications. Yet another team of students created a talking-head video in which they explained a visual framework they had invented to guide the design of project-based learning. They made it so students could click on a part of their visual framework to get a short snippet of the explanation. Based on all of the foregoing video implementations, we were impressed by what the students had learned to do with video for learning and assessment and in a relatively short period of time.

Conclusion

Our modest goal for this chapter was engaging reader interest in the potential of video within multimedia for instruction and research. We observed that although digital media has put video in the hands of many, there has been surprisingly little work exploring its unique potentials for learning. To help people make some headway in light of the limited literature on video for learning, we tried to help people see that there are distinct learning outcomes, and we compared different techniques of assessment to help readers discern what makes these outcomes different. We also gave some examples of how to do videos that help learners learn and help people learn if they have learned. Finally, we aimed for some saying outcomes by providing select facts and explanations about why certain forms of presentation affect different types of outcomes. Ultimately, we suspect this would have all been much more effective had we used video in an interactive multimedia context. Nevertheless, we hope that we have provided some impetus for people to consider the value of designing video for learning. The digital era is not just about computer programs, it is also about digital video.

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