Knowledge check questions:
Is interactivity warranted during a narrated presentation?

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Abstract: This study considered the effectiveness of "knowledge check questions," during a narrated presentation. Classic instructional design literature encourages the use of these questions as a self-assessment during a presentation. However, empirical research conducted both in the classroom and in clinical settings demonstrated the need for delayed, as opposed to immediate, feedback. In addition, there is little empirical research which considers immediate feedback within narrated presentations, or their use as study materials over longer periods of time. This study considers this hybrid scenario of providing immediate feedback during a presentation, but also allowing students to study the materials as instructional support over longer periods of time. The study compared the performances of those using knowledge check questions to those who did not. The results showed that those learners who were exposed to knowledge check questions performed better than the control group.

Introduction

The use of "knowledge check questions" is a relatively new instructional strategy which is increasingly being used in online courses. These multiple choice questions are introduced into an e-learning lesson as an interactive component, with the expectation that this interactivity will improve learning by focusing the learner's attention on the key components of a lesson. The purpose of this study is to consider the efficiency and effectiveness of using knowledge check questions within a narrated presentation. It compares the learner performance of two instructional conditions. The study compared the posttest performance of online learners who had knowledge check questions (experimental condition) to those who did not (control).

The instructional strategy of including feedback and questions in a lesson goes back several decades. Even before the internet existed, researchers were considering adding questions with feedback to a lesson (Brackbill, Bravos, & Starb, 1962; Kulhavy & Anderson, 1972; Merrill, 1965; Skinner, 1958) but the current study is more concerned with how this strategy is being used today in e-learning environments and whether or not it is useful to include this kind of interactivity during a narrated presentation. In particular the article considers the uses of knowledge check questions in online course environments.

Literature

While the instructional technology underlying knowledge check questions is quite new, the literature describing the learning underlying this instructional technique is several decades old. The instructional strategy of providing feedback following multiple choice questions has been explored extensively. Perhaps the earliest educational researcher to consider this type of learning and instruction was Educational Psychologist, Sidney Pressey, who began this work back in the 1920s (Kulik & Kulik, 1988; Skinner, 1958). It was Pressey who first discovered that providing learners with questions and feedback had the power to teach. Kulik and Kulik describe Pressey as believing teachers could improve their effectiveness by providing learners with immediate feedback. While decades of clinical trials and classroom studies have shown feedback and reinforcement are useful during learning, the timing of that feedback with verbal information is in question.

Knowledge check questions as an instructional design strategy

There is actually a good deal of classic instructional design literature which supports strategies, like the use of knowledge check questions, or self-tests. Certainly the behaviorist paradigm considered feedback and reinforcement. Skinner followed Pressey to produce teaching machines in the 1950s (Skinner, 1958) and many researchers followed Skinner's lead to consider feedback within instruction. Early in his career David Merrill for instance, considered this type of research to develop instructional models that describe the inclusion of questions within a learning sequence (Merrill, 1965). He used this question correction/review instructional sequence to help those learners who initially missed material during an instructional sequence. By providing question feedback learners could recover when they had made a mistake, to later perform as well as those who initially understood the material presented during the presentation. This question/feedback sequence is the underlying model used in today's knowledge check instructional strategy.

Gagné's nine events of instruction (Gagné, 1965) are a helpful guide in this discussion because it provides some level of clarity about the sequence and design a narrated presentation. There are many steps in Gagné's nine events of instruction that can help improve the quality of a narrated presentation. Certainly, designers should provide learners with a set of learning objectives at the beginning of a narrated lesson. This provides structure to the instructional sequence, and can act as an advanced organizer to explain the topics being covered. More importantly these objectives can also serve as the content for knowledge check question development. Aligning knowledge check questions to specific learning/performance objectives helps to ensure that those learning objectives have been met (Lewis, 2003). The content presentation should be structured in a logical manner, perhaps based upon the learning objectives. This provides for a solid structure for the content presentation. Knowledge check questions themselves act as a way for learners to interact with their instruction, and to fulfill Gagné's practice event. Next of course is feedback as an instructional event. The feedback/questioning sequence allows the narrated presentation to serve as a simple cognitive tutor. It can be argued that the feedback provided by knowledge check questions 1) will catch the attention of the learner and; 2) focus the learner on relevant material (Gagné, 1965; Gagné, 1985). Also as Merrill (1965) posited, these questions allow learners to recover if they have misunderstood material, or have misconceptions about previously covered material. In addition, depending on how a lesson is structured, knowledge check questions can help diagnose deficiencies and reroute a learner to previously covered material, providing for remediation.

The above literature makes for a strong case for the use of knowledge check questions during an e-learning course. This instructional technique should allow learners to perform better on post tests than those who do not have the support of these questions, but this is still an assumption. Also given the prevalence of this instructional strategy, one might expect empirical findings to support the use of knowledge check questions as an instructional strategy, but the literature concerning feedback and questioning within a learning sequence is somewhat mixed, and conflicting (Kulik & Kulik,1988; Kluger & DeNisi, 1996). In several cases the literature actually suggests against the use of immediate feedback as an instructional strategy (Bangert-Drowns, Kulik, Kulik, & Morgan, 1991; Brackbill et al., 1962; Kulik & Kulik, 1988; Kulhavy & Anderson, 1972).

Learning that results from "knowledge check questions"

The use of "knowledge check questions" is an instructional strategy employed by instructional designers as they develop narrated presentations. The learning that results from this instructional strategy is due to the presentation of the question and the feedback that follows. This section details the literature concerning this instructional strategy, but more specifically two types of feedback: immediate and delayed feedback. Many studies over several decades have shown that the presentation of feedback immediately following the presentation of a question may be detrimental to learning (Brackbill et al., 1962; Kulik & Kulik, 1988; Kulhavy & Anderson, 1972). These studies and many others have found that delayed feedback is more effective than immediate feedback.

Kulik and Kulik (1988) conducted a meta-analysis to consider the combined results of 53 studies which had considered the timing of feedback. They found that if feedback is supplied later than usual, many seconds to days later, learners perform significantly better on post tests than those who received immediate feedback. Their results confirmed the results of previous researchers (e.g. Kulhavy, 1977) to find that delayed feedback is a better instructional intervention for those learners that are trying to acquire verbal information provided in a multiple choice test, especially if that knowledge is tested days or weeks later.

A larger more extensive meta-analysis was conducted by Kluger and DeNisi (1996). This meta-analysis included 607 effect sizes dating back to the beginning of the 20th century. This study was much more generalized in that it considered the general feedback of feedback interventions. It actually found a significant result in favor of feedback interventions. Despite these findings, Kluger and DeNisi emphasized that a significant minority (one third) of those studied had a negative response to feedback interventions. Kluger and DeNisi pointed out that there is a widely held belief that feedback interventions will improve performance. However, as they argued, responses to feedback are widely variable, and often produce negative or debilitating effects on performance. Unfortunately this negative influence on performance effect is widely ignored and poorly understood. According to Kulhavy and Anderson (1972) the history of this misconception ("the feedback hypothesis," the expectation of positive results given feedback), goes back many decades to Thorndike and his "law of effect" (Thorndike, 1913). As Kulhavy and Anderson (1972) discussed animal studies, like those conducted by Thorndike, are inconsistent with human studies, when immediate feedback is being considered. This is because humans react differently when presented with language-based materials (Brackbill et al., 1962; Kulhavy & Anderson, 1972; Sassenrath & Yonge, 1968). Humans use their language abilities to recall and relate their instructional materials to their prior learning (Sassenrath & Yonge, 1968). Feedback in this situation is primarily useful for the correction of errors (Kulhavy & Anderson, 1972; Guthrie, 1971) and therefore delayed retention is more beneficial to humans when they study language based learning materials (Brackbill et al., 1962; Kulhavy & Anderson, 1972).

Brackbill et al. were the first to document the differences in immediate and delayed feedback on performance (Brackbill et al., 1962; Kulhavy & Anderson, 1972). This is described as the delayed retention effect (DRE), but offered little explanation as to why humans react differently than animals during feedback interventions. Kulhavy and Anderson (1972) also considered this delayed retention effect (DRE). They found a positive learning effect for delaying feedback (a day or more) as opposed to immediate feedback. Unlike Brackbill et al. (1962), Kulhavy and Anderson provide a theoretical explanation for the delayed retention effect. Both groups had provided learners with paper-based multiple choice tests and then either gave them the answers to the tests either with the tests or a day later. Both groups of researchers found that students performed better on post tests if they were provided the answers in a delayed manner. They proposed that this delayed response effect was due to the fact that learners would probably forget their incorrect responses, at a delayed presentation of the correct response, thus having less interference from these correct responses. Kulhavy and Anderson (1972) described this as the "interference-preservation hypothesis" (p. 506) or what is now known as "interference-preservation theory" (Kulik & Kulik, 1988, p.80). According to this theory, the incorrect response may be too close in time to the presentation of feedback. So the memory of the incorrect response creates interference to the presentation of corrective feedback, causing the learner to fail to discriminate between the correct and incorrect response. During the delayed retention test, these learners are unable to recall the correct response, thus the error response is preserved (Chaparro, 1990).

Kulhavy and Stock (1989) proposed a model that shed some light on the mechanisms behind learner responses during question/feedback instructional sequences. They proposed that much of the research prior to the late 1980s was based on an overly simplistic model of actual learner responses. This oversimplification is based upon a behaviorist "black box" conception of feedback and reinforcement. Kulhavy and Stock's new model "the certitude model of feedback" goes beyond this simple stimulus response approach, to consider the learner's intentions. Until this model, many researchers only considered a learner's response to be either correct or incorrect. They state that a learner response is more complex and may be due to a number of factors. For instance, a learner

could blindly guess the correct answer or choose an incorrect response because they misunderstood the question. Poorly worded questions can cause a learner unintended difficulties.

The Kulhavy and Stock's certitude model of feedback goes beyond learner feedback to integrate the factors of learner confidence, feedback complexity, and error correction (Mory, 2004). Mory (2004) describes this model as the most comprehensive to date. This certitude model considers the certainty of the learner's answer (response certitude). Kulhavy and Stock measured how certain learners were, separately from the answer correctness. They explained that with a lack of certainty, there is some discrepancy in what the learner knows and what they answer. Response certainty relies on a learner's metacognitive abilities (Mory, 2004) and when there is uncertainty a discrepancy exists. Kulhavy and Stock proposed that the greater a student's uncertainty the more time they will consider the feedback provided. They were able to demonstrate that the likelihood of a correct posttest response increased, with an initial response certainty level. In other words the more certain students were the more likely they were correct. These researchers were even able to relate response times to certainty.

In Kulhavy and Stock's certitude model, feedback is considered to have two components, verification and elaboration (Kulhavy & Stock, 1989). Verification allows the student to determine if their response is correct or incorrect. Other information acts as elaboration to provide an explanation for why the answer is correct or incorrect. Kulhavy and Stock use the term "elaborative feedback" to describe any additional information. This additional information alters the type and complexity of the feedback that a learner receives. Narciss and Huth, (2004) discuss several types of elaborative feedback and propose that these statements may include 1) an explanation for why the answer is correct or incorrect; 2) information about the types of error; 3) hints about useful sources of information; 4) hints about procedures; 5) hints about problem solving strategies; and even 6) Socratic questioning.

Finally, it should be stated that there is no perfect form of instruction or assessment. There are several disadvantages associated with multiple choice tests, both as a form of instruction and as a means of assessment. Dufresne, Leonard, and Gerace (2002) propose that this form of testing may be a false indication of conceptual understanding. This is because there is always some chance a student can guess the correct answer (Kuechler & Simkin, 2010). In addition multiple choice tests can be written at varying levels of difficulty. However these disadvantages are also offset by their advantages. An important advantage discussed in this paper is that multiple choice tests (or knowledge check questions with feedback) can act as a means of tutoring learners, to help guide and focus their attention during a content presentation. Even though other forms of assessment may test higher levels of thinking, they are not as efficient at assessing large quantities of factual or conceptual material. Certainly this form of questioning has become quite popular among those testing undergraduate students, because the grading of these exams can be automated (Dufresne, Leonard & Gerace, 2002). The point of this discussion is not to support any one form of assessment over another, just to state that each form of assessment has its own advantages and disadvantages. While many authors suggest teaching at higher levels of thinking, educators must at some point cover the basics.

This literature has explained that when it comes to allowing a student to review feedback, they 1) should be told if their answers are correct or incorrect and 2) the timing of this feedback should be delayed if possible. If an online student is allowed to review a presentation more than once then this scenario is conducive to learning for it provides both immediate and delayed feedback. According to Kulhavy and Anderson (1972) this allows a learner to forget incorrect responses in an effort to learn verbal information. This then leads to a question concerning a hybrid scenario involving both delayed and immediate feedback, and how that instructional strategy will affect learning over time.

Research question

When an instructional designer uses a knowledge check question, they are requiring the learner to review a narrated presentation. The presentation would pause for a moment and then present the learner with a question about the material that they had just reviewed. Learners would then answer that question and subsequently be supplied with immediate feedback. We provided learners with this instructional strategy and in doing so asked the following research question:

Do knowledge check questions during a multimedia presentation impact student learning?

We hypothesized that learner performance would be improved given the presentation of knowledge check questions, given students had the ability to access that narrated presentation over time. We felt learning would be positively affected given learners would access these presentations over several weeks and would likely study the presentations more than once, resulting in both immediate and delayed presentation feedback.

Methods

The intent of this study was to determine if the presence of knowledge check questions would impact student learning over time. It was hypothesized that the presence of knowledge check questions would have a positive impact on learner performance. The design of the study was simple, for it had one independent variable, the presence of knowledge check questions. It also had one dependent variable: test score on a post test.

The Sample

The participants for this study were undergraduate students at a large southeastern university. These individuals took part in one of two identical course sections of a fully online course called "Introduction to Public Health" during spring 2010. A total of 284 students took part in the study, and were randomly divided into two groups, the experimental group (n=141) and control group (n=143).

Instructional materials

The instructional materials developed for this study were narrated presentations that included lower level knowledge-based multiple choice questions. These presentations were developed as a part of the regularly scheduled online course for an undergraduate minor in the College of Public Health. Five presentations were developed in Microsoft PowerPoint 2007. Two of these presentations were broken into two separate parts based upon the content, for a total of seven presentations. The PowerPoint was narrated by recording a subject matter expert. Recordings were converted to narrated presentations using Articulate Presenter 5.4 (Articulate, 2009a) (see Figure 1).

Narrated presentations were made available via the web using the Blackboard learning management system, as a series of flash-based presentations. Questions were developed separately and then included in the Articulate presentation with Articulate Quizmaker 2.3 (Articulate, 2009b). Two types of presentations were developed, those with and without knowledge check questions. This allowed for the development of an experimental instructional condition, those that received knowledge check questions, and a control group that only received the narrated presentation which did not receive these questions or feedback. At the onset, each narrated presentation provided the student with a list of performance objectives. The knowledge check questions were based on the learning objectives of the presentation. One question per objective was developed. An effort was made to limit each learning objective to one measurable performance.

Kuechler and Simkin (2010) discuss the use of Bloom's taxonomy as a means of determining the differences in multiple choice questions. Bloom's taxonomy (Bloom, 1956) can be broken down into six levels: knowledge, comprehension, application, analysis synthesis, and evaluation. There was an attempt to write all knowledge check questions at the knowledge and comprehension level. In keeping with the research of Kulhavy et al (1985), question feedback was kept fairly simple and an attempt to pose complex feedback was avoided.

Narrated presentations ranged in length from 34 minutes to 72 minutes and were highly conceptual in nature. The questions tested by the knowledge check questions were not scored, but students had to answer the questions to continue to view the presentation. The topics of these presentations were "Health behaviors", "Psychosocial Factors of Health behaviors", "Tobacco", "Diet", "Poor health & Physical Inactivity", and finally "Injuries are not accidents."

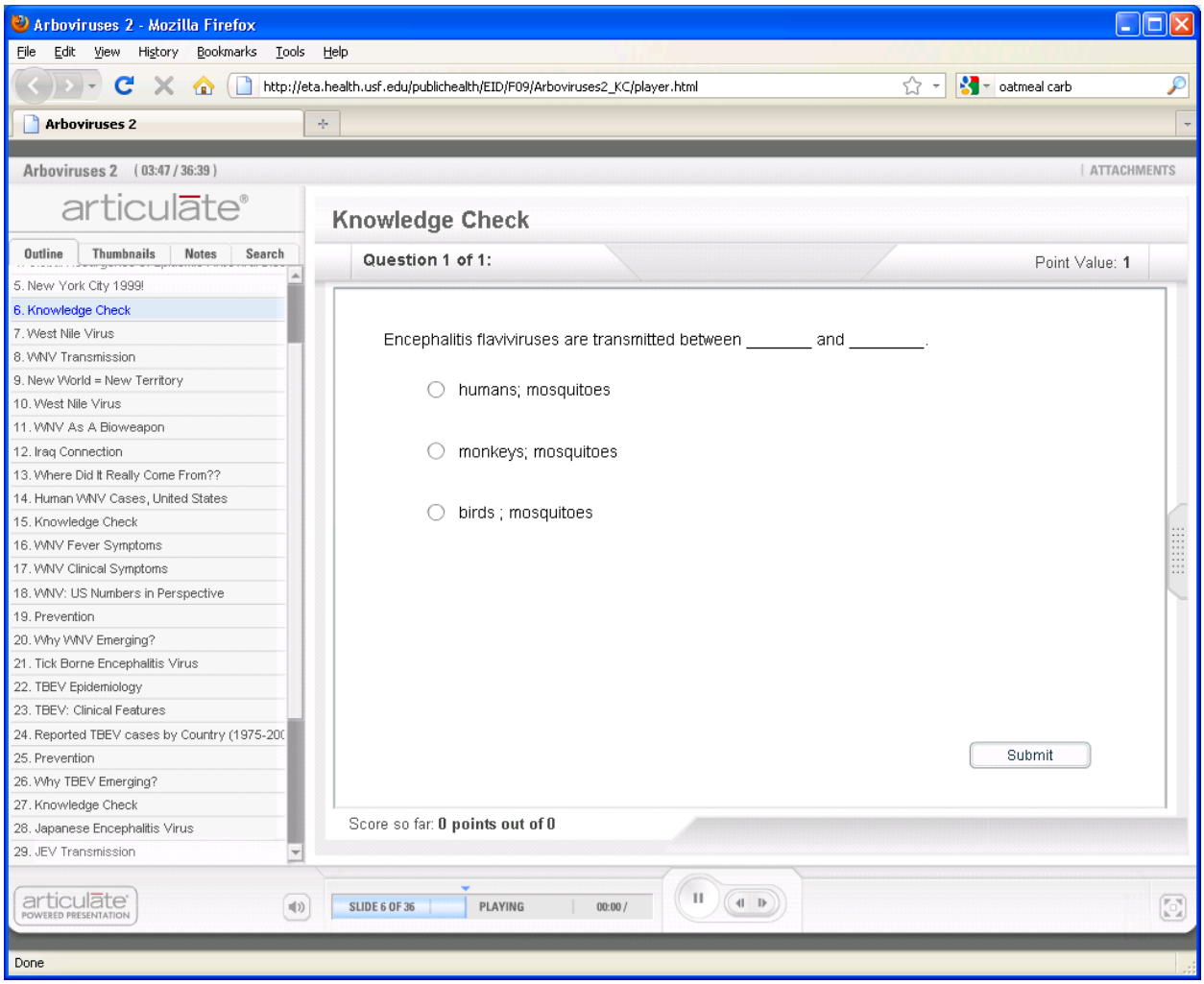

Figure 1. Knowledge Check question within an Articulate presentation

Procedures

An online course was developed and presented via the Blackboard 9.0 learning management system (Blackboard, 2009). The course roster of the course was randomly divided into two groups (experimental and control). A list of students in each group was developed and students were placed into two Blackboard groups. Blackboard allows for the presentation of instructional materials based upon group identification. The experimental group was provided with narrated presentations that included knowledge check questions. The control group received identical presentations that did not include knowledge check questions.

A post-test was developed in Microsoft Word 2007 and then uploaded into Blackboard as a quiz within an online course with Respondus 4.0. Post-test scores were downloaded into a Microsoft Excel 2007 spreadsheet and then analyzed using the Excel Data Analysis tools to perform a "t:test: Two-Sample Assuming Unequal variances."

Results

Some attrition occurred as some students did not take the post test. A total of 140 control group students (out of 143) and 136 (out of 141) experimental group students took the post test. However there was no significant difference in group post-test score based on a two-tailed t-test, since t (269) = -1.88, p = 0.061 α=0.05 (see Table 1). The experimental group test score mean (M = 38.44, SD = 30.74) was not significantly different from that of the control group (M = 37.07, SD = 42.33).

Table 1

Post-test scores

	Experimental group	Control group
n	136	140
post-test score		
M	38.44	37.07
SD	30.74	42.33

Discussion and Conclusions

We hypothesized that the development of narrated presentations which included knowledge check questions, would be beneficial to learners and would result in improved learner performance. While the results did not find a significant difference between learner groups, as expected, the experimental group, those who received knowledge check questions, performed better on average than those who did not have access to knowledge check questions. Thus in answer to the title of this paper the interactivity (in the form of knowledge check questions) is warranted during a narrated presentation, because these questions do on average help learners to learn. While it cannot be assumed all learners in the experimental group used, or even made repeated use of, the narrated presentations as a study tool, these presentations were made available to these learners for a period of several weeks and it is expected that these learners did use them to study and prepare for the test, improving their test scores (used as this study's dependent variable). Since students had to listen to the narrated presentation to obtain necessary information for the post test, it is likely that the vast majority of the students viewed it at least once. The presentations were made available to learners for a period of several weeks, so it is likely some learners in both the experimental and control group viewed the presentations more than once for review purposes.

The results of this study do not provide unequivocal support for providing knowledge check questions within narrated presentations. However, the results do not provide evidence against the use of knowledge check questions either, and actually support their use since learners were positively affected by their presence. We therefore conclude that instructional designers should make use of knowledge check questions in the development of narrated presentations, if these presentations are to be presented to learners more than once, and that learners have access to these presentations for extended periods of time as a study tool.

As with all studies, more questions were generated than answered. It is suggested that future researchers reconsider this question of whether knowledge check questions do indeed impact learner performance. The timing of feedback is somewhat in question given the literature on this topic and therefore future researchers should consider the timing of feedback within a narrated presentation. Another question to be asked is "do learners who have knowledge check questions available perform better with more complex feedback?" …or with less complex feedback, as suggested by Kulhavy et al. (1985). Learners have long term and short term memories; in the case of immediate feedback, the limitations of short-term memory may work against a learner. Like Kulhavy and Anderson (1972), researchers should consider many factors, including memory, the timing of feedback and the cognitive load placed on the learner.

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