Effects of Varied Animation Strategies in Facilitating Animated Instruction

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Background

The use of animation and audio as a virtual panacea for everything from advertising to educational videos and instruction has created the presumption that any materials that use them 'must be better!' Now doubt that the addition of animation can improve message delivery on a number of scales, but the use of animation regardless of message and with little concern for systematic placement may be causing more harm than good. Combined with the increasing prevalence of computing technology and increasing ease of development on standard workstations the integration of animation in web-based instruction is a more realistic possibility. This study explores the effect of animation on higher order educational objective achievement in a web-based, self-paced programmed instructional unit on the human heart and its functions for undergraduate students with majors outside of the life sciences.

Introduction

In instruction the use of pictorial media has long been considered to be an important instructional variable supported by a number of theoretical considerations. Kulik and Kulik (1985) reported that computer-based instruction enhances learning and fosters positive attitudes toward instruction with college students. Unfortunately most of the studies that have been carried out examining animation in computer-based and web-based instruction have been cursed with confounding and poor designs. (Rieber, 1991; Dwyer 1978; Park & Hopkins 1993) There are various reasons for the conflicting results and inconclusive results. Dwyer (1978) pointed out that one of the major problems with media research was that it didn't describe the types of learning tasks or objectives that it expected the participants to achieve. Sadly upon review of available literature dealing with animation in computer-based and web-based instruction this still appears to be the case. In the subsequent literature review this author makes a case that not much has changed in the past 25 plus years in media research since Dwyer's observation. Further the questions of effectiveness in practice and convergence of theory remain largely inconclusive.

Definition

With a lack of definition of terms being one of the major criticisms of the research reviewed in the subsequent pages the researchers will explicate their operating definitions for animation. Animation is a sequence of images played in rapid succession such that to the human eye the result is apparent motion (Park & Gittelman, 1992) and is generally used in instructional materials for one of three purposes: attention-gaining / attention-direction, presentation, and practice (Rieber, 1990).

Literature Review

Paivio's dual coding theory (DCT) asserts that images and verbal processes together determine learning and memory performance (Clark & Paivio, 1991). According to Paivio's (1971, 1986) and later Clark and Paivio's (1991) explanation, using the information processing model and the spread of activation in the brain, the links between verbal and non-verbal symbolic storage can trigger each other, "…this spreading activation results in complex patterns of arousal among the representations in the network." (Clark & Paivio, 1991, p. 154) Further, Clark and Paivio propose that both types of mental representations have dedicated channels for the processing and encoding of information. Tulving (1976) suggests that information can be processed on several levels in parallel processes and a logical extension of this using information processing as a guide is that the parallel processing can aid in the transfer of information into long-term storage. The concept of parallel processing is not new to cognitive psychology, and will be generally accepted by the researchers. What is of interest to the researchers stems from the apparent inconsistencies in the literature regarding the use of animated sequences to facilitate learning or achievement.

Animation Studies and Findings

Park and Hopkins (1993) suggest that educational research on visual displays evolved from two distinct camps: the behaviorist with work by Guthrie, Skinner, and Thorndike on eliciting desired responses after some stimulus, and the cognitive with work by Paivio and his Dual Coding Theory (DCT). Tulving and his concept of 3 major types of memory: episodic, semantic, and procedural would also fall under the cognitive branch in this division as well. (Gredler, 2001, p. 171)

In Rieber's 1990 review of 12 studies spanning 25 years, he found inconsistent results in the effects of animation on achievement and learning by extension. Similarly, Park and Hopkins (1993) reviewed 25 empirical studies, 17 of which dealing directly with computer based instruction and also reported mixed results. Dwyer and Dwyer in a 2003 presentation reviewed 5 animation based studies using similar content and identical assessment tools on a total of 781 subjects, and found only three cases out of the 72 examined where animation showed significant benefits over static visuals. Owens and Dwyer (2003) in an unpublished study actually found animation to be less effective than static visuals at higher levels of learning.

In a study published in 1988 by Reiber and Hannafin looking at the effects of animated or textual orienting activities on learning in computer based instruction with fourth, fifth, and sixth graders, they report that neither text-based or animated activities were powerful influences on learning. This studies content was based on Newton's laws of motion, and the authors report that a 24 item posttest was administered with a KR-20 reliability of .83 overall. While not explained they also report that validity was established through expert review by independent science teachers.

In a study published one year later in 1989, Reiber ran another factorial study 3x2x2 looking at more factors comparing graphic type (animation, static graphic, not graphic) and text type (text, no-text) and practice type (relevant, irrelevant). Additionally within subject he examined factual verses application objectives and near verses far transfer. The overall reliability of the improved dependent measures was .91. In this study "The lack of main effects among the embedded elaboration conditions was surprising." (Reiber, 1989, p. 439) Two years later Reiber (1991) ran a simple version of the study looking only at graphic type (static graphics verses animated graphics) and practice type (simulation verses simulation with questions) found significant effects in favor of animation for near transfer on incidental and intentional questions.

In a 1998 animation study conducted by Park using a computer based instructional unit on electronic circuit repair he reports that static graphics with motion cues can be used instead of full graphical animation as they both were equally effective on the performance and transfer tests that were administered. Will this finding may well be true, Park did not identify the level of educational objectives measured or report any reliability or efforts to support validity on his dependent measures. If the dependent measures were measuring factual or conceptually based knowledge than the finding may offer some direction an support but with out it being reported the readers are left to their own devices and field suffers once again.

"Although much research has been done on the effectiveness of static visuals (Dwyer, 1978), little research has conducted on animation's instructional effects. Empirical data that are available are inconsistent." (Reiber, 1990, p. 78) In the almost 15 years since Reiber wrote this statement, little has changed. More studies have been run, but a general consensus has yet to be reached. This lack of consistency stems from several different sources in both internal and external validity issues. There are the more obvious issues of poor study design, varying and insufficient sample sizes, issues with content relevance, lack of systematic process for placement of treatments, use of assessments with out evidence of -or even reported assessment reliability and content validity. Even with all of these issues surrounding the existing literature, one of the most egregious errors revolves around the lack of definition of the types or methods of animation used and the levels of instructional objectives that were being addressed in the studies. The failure of previous researchers to provide reasoning for placement of the interventions casts yet more doubt on use and application of reported results. With out a systematic process for placement of the animation the net effect may well be supporting an instructional objective that is already sufficiently addressed in the instruction thereby wasting the time and attentional resources of the participants as they would have responded with the correct answer before the added stimulus was introduced.

Literature Review Summary

The numerous studies addressing animation and its effects are asking good questions, but are for the most part lacking in execution in some major areas of concern. Gagne (1985) in his book entitled The Conditions of Learning, proposed that there are different types of learning and that each type of learning requires a different approach. The problem remains that while all the previously mentioned studies are asking good questions they are not providing sufficiently based answers. The need for the systematic placement of independent variables, which previous studies lack, and the use of sound instruments with reported reliability, which previous studies also lack, is paramount in accurate interpretation of results.

How This Study is Different

Where this study set itself apart from the previous studies in the literature is through the systematic placement of the animation in a programmed instructional unit. Further, in this study the researchers have gone to great pains in the pilot studies to refine the programmed instruction so that the participants have the necessary factual and conceptual knowledge to build upon for higher order learning to take place. “An awareness of the fact that that there are different kinds of educational objectives each requiring specific prerequisites is crucial to educators who aspire to employ the visual media effectively” (Dwyer, 1978, p. 43). Additionally this study used instruments with previously reported reliability and demonstrated discriminatory power for its dependent measures. It is hypothesized that the use of the animation can reduce the overall cognitive load on the participant there by allowing them to queue to the import information in the instruction and process it more effectively.

Statement of Purpose

Specifically, this study sought to examine the effectiveness with which different types of stimuli, varied animation strategies, can be used to complement a web-based programmed instruction unit to improve learner achievement on four different types of educational objectives.

Design and Methodology

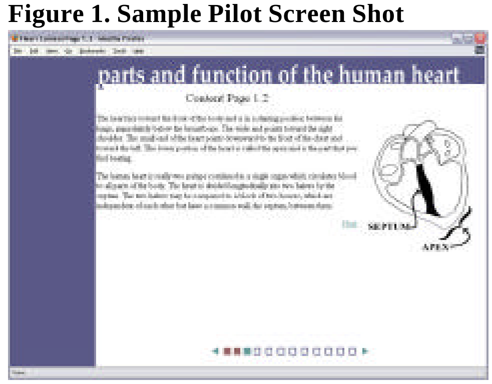
Eight-Eight undergraduate students enrolled in lower-division management, educational psychology, and information sciences technology classes were randomly assigned to one of three treatments in a randomized 1 X 3 post-test only experimental design. The type of animation strategy used was considered to be the independent variable with three levels (control with base animation employed, simple level with base animation and simple reveal, and complex level with base animation and progressive reveal). Dependent variables were the scores achieved on the criterion measures by the participants. Participation in the study was voluntary and at the recruitment sessions the students were able to select their preference of times to report to a list of labs were researchers would be waiting.

Systematic Placement and Development

Two pilot studies and the current study were run from September 2003 through September 2004 to systematically apply the effective use of the animated stimulus in the final iteration reported here. A brief explanation of the two pilot studies and treatments development will be covered in the following section.

Pilot Study #1: (n = 12) This first pilot and genesis for the larger study was done in response to criticism in the literature that one of the reasons for conflicting results was that it was unreasonable to expect any achievement differences at higher levels of educational objectives if the lower levels still were not addressed in sufficient detail as to achieve an acceptable score (average of 90%).The first pilot study was conducted to facilitate the development of the future instructional treatments and test the programmed instructional units effectiveness. This pilot study took the instructional booklet developed by Dwyer and Lamberski in 1977 and ported the treatment over to a web-based instructional unit and added five quizzes to make it into a programmed instructional unit. There was no use of animation and only a recreation of

Figure 1. Sample Pilot Screen Shot



the static visuals used in the original paper based instruction (figure 1). The purpose was to identify items with a high of difficulty (.60 or below on the drawing and identification tests) to determine areas where the static visual instruction might be complemented by a refined programmed instructional unit to further improve student achievement.

Pilot Study #2: (n = 138) This second pilot built off of the lessons learning in first pilot on the programmed instructional unit. Adaptations and corrections were made in the programmed instruction in hopes of pushing achievement even higher. Additionally there were questions to the effectiveness of our programmed instructional unit. If you are building a structure you need a good foundation, the factual and conceptual information is that base for higher order objectives was specifically stressed in the programmed instruction. Simple (base) animations were developed using flash and fireworks for the graphical development. In this study three levels were established: First there was the instructional script from Dwyer and Lamberski (1977), with static visuals only totaling 20 content pages. The second treatment (figure 2) was the programmed instructional version with the same script broken down into no more than 2 parts or concepts per webpage for a total of 28 content pages with embedded quizzes after every 5 or six parts of the heart were covered in the first 17 frames. The third treatment (figure 3) has the same breakdown and structure as the programmed instructional unit, but added basic animation to help facilitate and reduce the information processing load on the part of the subjects.

Figure 2. Pilot #2 – Simple Screen Shot

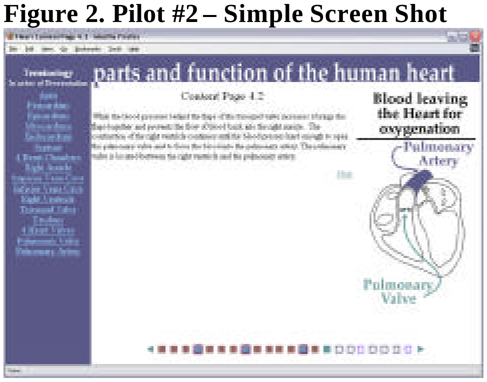
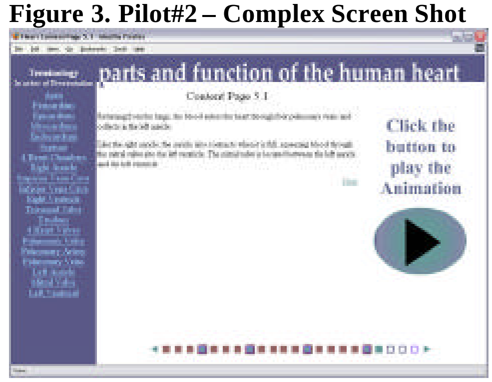
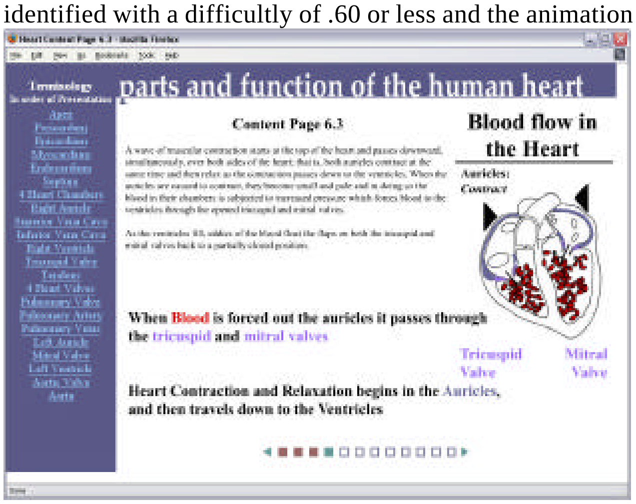
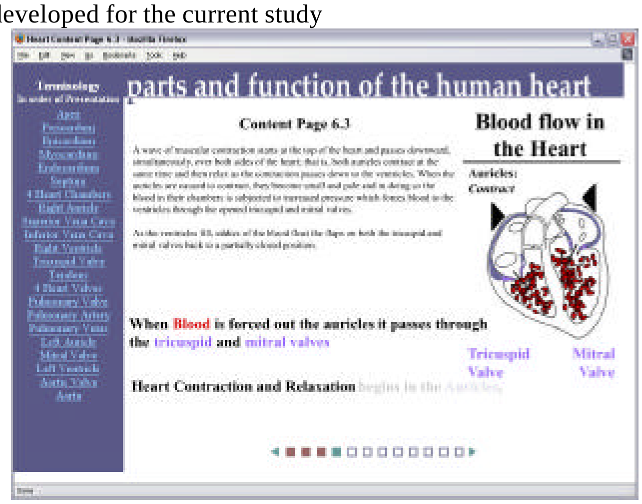


Figure 3. Pilot#2 – Complex Screen Shot



After the study was run and the groups of students (control n= 47, programmed instruction n = 47, programmed instruction + animation n = 44) data analyzed five items from the drawing test, nine items from the terminology test, and ten items from the comprehension test and zero items on the identification test were identified with a difficultly of .60 or less and the animation developed for the current study





Current Study: In this iteration of the study there are three levels of animations explored. The complex treatment from pilot study number 2 with the placed animation only at the right of center text area served as the base animation or control group. The second treatment (figure 4) used the same base animation as the control but added another effect of a simple reveal and fade that cycled two times than stayed on the screen until the subject moved on. The third treatment (figure 5) used the same base animation as the control but added another effect of a progressive reveal and fade that cycled two times than stayed on the screen until the subject moved on. The belief is that the forced information processing through the use of progressive display of information will not only be more effective in directing attention but also establish links in memory that the simple and control treatments may not.

In the complex or progressive reveal treatment the subject was presented three units (a word, or a symbol, or a group of words) of information in succession. The simple reveal treatment had the same information but it was displayed and faded in all at once. Additionally, in the progressive reveal treatment the part of the heart or first part of the statement faded in, then in the on screen animation the corresponding part blinked three times, then the next two sections of the phrase or idea faded in after a short delay. For each thought or idea the process was repeated once for a forced display of the information happening twice on any given screen. At the conclusion of this animated sequence the subject could choose to view the entire animation again or move on to the next webpage. It should be noted that the complex animations, by the very nature of the progressive reveal, required more time to display and averaged around 22 seconds run time for the base animation and the progressive reveal. In the simple treatments where the idea was revealed all at once after the base animation the average run time was around 15 seconds. In the control group where only the base animation was displayed the average was around 11 seconds.

The subjects were given a moderate level of user control, they could replay or view previous animations at any time during the instruction, but were required to view the animation on a screen before being allowed to progress through the lesson. Additionally the environment allowed that subjects to pull up static images of all the parts of human heart after they had been covered in the instructional unit. There was a degree of linearity in programmed instructional part of the materials as there were required to correctly answer 4 out of 6 questions on the quizzes or they were automatically sent back the beginning of that section, generally 3 pages prior. If an acceptable score was achieved on the practice quizzes they were able to progress forward normally.

Dependent Measures

In the pilot studies and in this iteration of the study four criterion measures developed by Dwyer (1965) each consisting of 20-items was employed to assess the participant's achievement. It should be noted that with the exception of the drawing test, which was administered in a paper pencil format, all other assessments and quizzes were administered in an online format to minimize any mixed medium effects between the lesson and the assessment. Reported reliability coefficients (KR-20) and brief explanation adapted from Dwyer (1978, pp. 45-47) of each tool are outlined below:

Drawing Test. (K-R 20: .91) A 20 object queued recall test designed to evaluate student ability to construct and/or reproduce items in their appropriate context. The drawing test provided the students with a numbered list of terms corresponding to the parts of the heart discussed in the instructional presentation. The students were required to draw a representative diagram of the heart and place the numbers of the listed parts in their respective positions. For this test, the emphasis was on the correct positioning of the verbal symbols with respect to one another and in respect to their concrete referents. Conceptual level educational objectives were addressed with this assessment.

Identification Test. (K-R 20: .86) A 20 question - 5 option multiple choice test designed to evaluate student ability to identify parts or positions of an object in the heart. This multiple-choice test required students to identify the numbered parts on a supplied detailed drawing of a heart. Each part of the heart, which had been discussed in the presentation, was numbered on the drawing. The objective of this test was to measure the ability of the student to use visual cues to discriminate one structure of the heart from another and to associate specific parts of the heart with their proper names. Factual level educational objectives were addressed with this assessment.

Terminology Test. (K-R 20: .87) A 20 question - 5 option multiple choice test designed to measure knowledge of specific facts, terms, and definitions. This multiple-choice test consisted of items designed to measure knowledge of specific facts, terms, and definitions. The objectives measured by this type of test are appropriate to all content areas that have an understanding of the basic elements as a prerequisite to the learning of concepts, rules, and principles. Specifically, conceptual level educational objectives were addressed with this assessment as a spring board for high level objectives.

Comprehension Test. (K-R 20: .84) A 20 question - 4 option multiple choice test designed to measure a type of understanding in which the individual can use the information being received to explain some other phenomenon. This multiple-choice test consisted of items where given the location of certain parts of the heart at a particular moment of the heart beat cycle, the student was asked to determine the position of other specified parts in the heart at the same time. This test required that the students have a thorough understanding of the heart, its parts, its internal functioning, and the simultaneous processes occurring during the systolic and diastolic phases of the heart beat. The comprehension test was designed to measure a type of understanding in which the individual can use the information being received to explain some other phenomenon and addressed the rule / procedural knowledge educational objectives.

Total Criterion Score. (K-R 20: .95). All items contained in the previously noted individual tests were combined into a composite test score to measure overall learning and understanding.

Validity of Dependent Measures

Upon examination of the content pages, instructional script and materials *face validity* is believed to be evident by the researchers. Given that the tests were textually identical in the web based version used in this study *content* and *construct validity* for dependent measures is assumed as part of the original instruments umbrella. An explanation of the process used in establishing validity is covered in detail greater in Dwyer 1978 and in his 1965 thesis. In short the instructional materials and dependent measures were put through content expert and educational expert review with objectives and descriptions were developed and employed during test development phase by Dwyer originally in 1965 as part of his doctoral thesis.

Results

For statistical analysis the alpha level was set a priori at the 0.05 level, and an ANOVA was conducted on each dependent measure. Where significant differences are obtained, Scheffe or Dunnett C, according to Levene's test of homogeneity of variance, follow –up procedures were implemented. From the outset of the study it was the intention of the researchers to analyze the data from each criterion measure individually and collectively and in an effort to comprehensively examine the effects the animation. In the table 1 below the descriptive statistics for all items are displayed.

Table 1. *Means and Standard Deviations for Each Treatment on Each Dependent Measure*

Dependent Measure Mean # Correct Standard Deviation.	Base Animation Control Group (n=29)	Base Animation with Reveal (n=31)	Base Animation with Progressive Reveal (n=28)
Drawing			
Mean	15.97	16.00	18.07
S.D.	3.26	3.61	2.26
Identification			
Mean	17.62	18.35	18.45
S.D.	2.47	1.70	1.99
Terminology			
Mean	11.93	13.65	15.10
S.D.	5.03	3.96	3.30
Comprehension			
Mean	11.00	12.55	12.79
S.D.	3.64	3.67	3.51
Total Criterion Score			
Mean	56.52	45.55	64.75
S.D.	11.90	7.76	8.75

Tables 2 and 3 show the results of the One–Way Anova and the appropriate follow up tests used. Significant effects were found on the Drawing (F=4.29 df (2,85), p=.02) and Terminology (F=4.25 df (2,86), p=.02) and Total Criterion (F=29.767 df (2,85), p=.001). In the case of the drawing test, after using Scheffe post hoc test it was determined that the progressive reveal group did significantly better than both the simple reveal and control groups. For the Terminology test, after using Dunnett C follow up test because it failed the Levene test of homogeneity it was determined that the progressive reveal group statistically performed significantly better than the control group with base animation only. When looking at the Total Criterion measure the assumption of Levene's test of homogeneity test was not supported and Dunnett C was implemented on the results. The results were statistically significant in all comparisons and best illustrated by Figure 6.

Figure 6. Total Criterion Means Plot

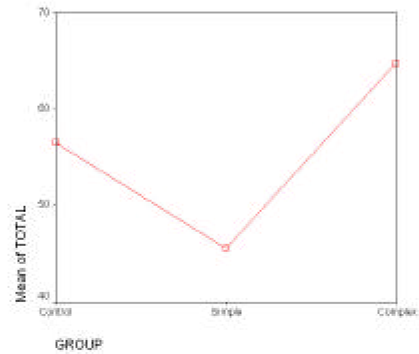


Table 2. *Results of Analysis of Variance Across All Items*

		Sums of Squares	df	Mean Square	F	sig
Drawing	Between groups	83.26	2	41.63	4.29	**.016**
	Within Groups	824.82	85	9.70		
	Total	908.08	87			
Identification	Between groups	12.00	2	6.00	1.40	.253
	Within Groups	369.10	86	4.29		
	Total	381.10	88			
Terminology	Between groups	146.26	2	73.13	4.25	**.017**
	Within Groups	1481.65	86	17.23		
	Total	1627.91	88			
Comprehension	Between groups	55.20	2	27.60	2.189	.118
	Within Groups	1084.44	86	12.61		
	Total	1139.64	88			
TOTAL	Between groups	5491.29	2	2745.64	29.77	**.000**
	Within Groups	7840.17	85	92.234		
	Total	13331.46	87			

Table 3. *Analysis of Variance Follow Up Tests With Significance All Items*

Test	Follow Up Used Levene Statistic Sig.	Group 1	Group 2	Mean Difference
Drawing	Scheffe	Complex	Control	2.11
	.13		Simple	2.07
Terminology	Dunnett C	Complex	Control	3.17
	.001			
TOTAL	Dunnett C	Complex	Simple	8.23
	.010		Control	19.20
		Control	Simple	10.97

Also of interest was the analysis run on just the items addressed in the treatments. For the Drawing test there were five items that had and item difficulty less than .60 after an item analysis. Similarly the Terminology and Comprehension tests had nine and ten items respectively that were specifically targeted. Table 4 displays the descriptive statistics for the items addressed. Table 5 shows the results of the analysis of variance and table six displays the appropriate follow-up tests and their significant results. It should be noted that there were no items on the identification test with a difficulty level less than .60 and therefore were not addressed. Also the terminology test was found significant with comparing all 20 items on the test but when looking at the 9 items addressed specifically it just misses the .05 alpha level coming in with p =.075.

Table 4. *Means and Standard Deviations for Individual Items Addressed on Each Dependent Measure*

Dependent Measure (# of items address) Mean # Correct Standard Deviation.	Base Animation Control Group (n=29)	Base Animation with Reveal (n=31)	Base Animation with Progressive Reveal (n=28)
Drawing (5 Items)			
Mean	3.28	3.81	4.50
S.D.	1.60	1.28	0.73
Identification (0 Items)	N/A	N/A	N/A
Terminology (9 Items)			
Mean	4.14	4.77	5.52
S.D.	2.49	2.29	2.01
Comprehension (10 Items)	5.14	5.06	5.21
Mean	1.66	5.21	1.78
S.D.			
Total Score			
Mean	12.55	13.65	15.32
S.D.	4.56	3.63	3.61

Table 5. *Results of Analysis of Variance Addressed Items Only*

		Sums of Squares	**Df**	**Mean Square**	**F**	**Sig**
Drawing	Between groups	21.45	2	10.72	6.62	**.002**
	Within Groups	137.63	85	1.62		
	Total	159.08	87			
Identification	None Targeted					
Terminology	Between groups	27.64	2	13.82	2.68	.075
	Within Groups	444.11	86	5.16		
	Total	471.75	88			
Comprehension	Between groups	0.31	2	0.15	0.05	.951
	Within Groups	258.38	86	3.00		
	Total		88			
TOTAL	Between groups	110.72	2	55.36	3.53	**.034**
	Within Groups	1332.38	85	15.68		
	Total	1443.09	87			

Table 6. *Analysis of Variance Follow Up Tests With Significance Addressed Items Only*

Test	**Follow Up Used Levene Statistic Sig.**	**Group 1**	**Group 2**	**Mean Difference**
Drawing	Dunnett C .004	Complex	Control	1.22
TOTAL	Scheffe .246	Complex	Control	2.77

Discussion

From the initial pilot study run in the fall of 2003 there has been marked improvement in the raw mean scores with each successive iteration beyond simple static visuals, first using programmed instruction, and then adding in basic animation, and finally with the additional animation strategy of simple reveal vs. progressive reveal. Results of this study have shown some statistically significant findings for some educational variable levels and on the whole but not for all educational levels.

The results of this study indicate that the use of animation when properly designed and positioned is an important instructional variable for complementing web-based instruction. However, it should not be seen as a panacea that can cure all the ills of instruction and education. Results have also shown that the use of animation is not equally effective for facilitating achievement across all of the different levels of educational objectives. Even when subjects have the perquisite knowledge required to build upon for success at the higher levels achievement is not guaranteed. In the case of this study the researcher went to great pains to ensure that lower level objectives where addressed in sufficient detail and we believe that we succeeded with the control group averaging almost 80 and 90 percent on the drawing and identification tests respectively.

One interesting note was the large drop in the overall and addressed items mean scores exhibited by the simple reveal group. Possible explanations of this apparent anomaly vary and were a frequent topic of discussion by the researchers. One suggestion is that of a statistical anomaly. We randomly assigned all subjects to treatments but there is still a chance that it was a random error. We are fairly certain that we have avoided common pitfalls in our research design but a replication study is currently planned for the spring of 2005 and this competing explanation can explored in more detail then. Another possible explanation discussed by the group was lack of motivation by the individuals randomly assigned to this treatment, but once again we used random assignment this should have distributed this equally across groups. Further, upon inspection of the data and answers keyed into the assessments there did not appear to be any obvious patterns or clues indicating an obvious lack of effort by students. Participants were also allowed to exit the study at anytime if they so chose. No one exercised this option but all subjects were made aware of it at the onset when they read and signed their informed consent forms.

One possibility that seemed to resonate with researchers dealt with the level of cognitive processing load, part of the underlying theoretical basis for the study, was exceeded. Even though the subjects in the simple reveal and progressive viewed the same content and all textual and graphical information was identical, the presentation of information in the simple reveal increased the cognitive processing load beyond their individual thresholds. It is suggested that the subjects could no longer focus and direct attention and that onslaught of information that was taken in for processing was quickly disposed of. While experiencing this process of overload the subjects actually missed the other bits of information presented in all treatments that the control and complex groups were able to attune to. In future studies qualitative data and questions asking the students to rate the data presentation may be included but make the assumption that the subject is aware of the overload, which may or may not be the case.

Another interesting point that needs to be explored further is that when all items in the comprehension dependent measure the analysis of variance returned an F-ratio of 2.19, p=.12 but when compared to items addressed the F-ratio is .05 and p=.951. When viewed in tandem it appears that most if not all of the variance increase was on the ten out of twenty items that weren't specifically targeted or addressed by treatments. Further analysis is required to address this question.

What remains to be seen is the transfer and replication of these findings in future studies. Transfer of the findings of this study can be logically extended other domain areas where information is organized in a hierarchal manner. However, widespread generalization of findings is a dangerous proposition; never-the-less, implications for practitioners can be generated so long as they are 'taken with a grain of salt' and not assumed to be fact but merely a possible lens from which to view a problem. The use of animation increased overall achievement on the parts of the learners due in large part to effects on the factual and conceptual levels. Given the cost of development for use of animation this should be considered within a contextual frame work of what is it worth to you? If similar findings can be achieved with well designed and systematically placed static visuals the benefits out weigh the costs. There were clear areas where progressive reveal animation strategies were better in facilitating achievement. This relates to the clarity of the relationship between the way the animation was designed and information presented. When choosing to utilize animation, specific attention needs to be devoted to the cognitive load on the individual. If items require too great a processing time than they can do more detriment than not using them at all in an instructional module.

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