# Effect of Visual Scaffolding and Animation on Students' Performance on Measures of Higher Order Learning

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## Abstract

*Animation is being used extensively for instructional purposes; however, it has not been found to be effective on measures of higher order learning (concepts, rules, procedures) within the knowledge acquisition and knowledge integration domains. The purpose of this study was to examine the instructional effectiveness of two visual scaffolding strategies (simple and complex scaffolding) used to complement animated instruction. About 90 undergraduate level students were randomly assigned to three treatments (control, simple and complex). After receiving their respective instructional presentation students took four tests – drawing, identification, terminology and comprehension. The results of a preliminary study indicated that animation has a significant impact on acquisition of factual and conceptual knowledge. On the other hand, visual scaffolding strategies, used as a complement to instruction that already involved animation did not have a significant impact on students' performance on measures of higher order learning.*

## Introduction and Theoretical Framework

### Animation in Multimedia Instruction

(Mayer & Moreno, 2002) have defined multimedia instructional environments as ones in which "learners are exposed to material in verbal (such as on screen text or narration) as well as pictorial form (including static materials such as photos or illustration, and dynamic material such as video or animation)" (pg. 87). The authors propose two theories of how students learn from words and pictures:

1. Information Delivery Theory of Multimedia Learning: Based on the theory that learning involves adding information to one's memory (Mayer, 1996). Multimedia instruction is effective in delivering information effectively to both types of learners – learners that prefer verbal presentation and those that prefer pictorial presentations.
2. Cognitive Theory of Multimedia Learning: Meaningful learning occurs when students mentally construct coherent knowledge representations (Mayer, 1996). This theory is based on three assumptions: (1) humans have separate channels of processing visual and verbal representation (dual-channel theory) (2) the capacity of short term memory is limited, and (3) meaningful learning (knowledge integrations) occurs when learners actively engage in cognitive processes such as selecting, organizing and representing knowledge.

Further, (Mayer & Moreno, 2002) have examined the role of animation in multimedia learning environments. Animation is defined as "[Animation] refers to a simulated motion picture depicting movement of drawn (or simulated) objects" (pg. 88). They found that "Animation can promote learner understanding when used in ways that are consistent with the cognitive theory of multimedia learning."

### Potential Problems with Multimedia Instruction using Animation

Animation and simulations are being utilized at all levels of instruction. However, most research which has identified positive gain from animation has reported it at the fact and concept levels (Reiber, 1990; Dwyer, 2003). One hypothesis that may be proposed to explain this phenomenon is that when students are expected to learn a hierarchy of learning outcomes, the cognitive load associated with the animated presentation and the content complexity provides a stimulus field which is too complex for effective assimilation (Young, 1993). Another hypothesis is that "The ineffectiveness of animation in facilitating higher level cognitive functions may be because learners do not possess the prerequisite facts and concepts to use in constructing rules and principles necessary for higher order comprehension." (Dwyer, 2003)

## Scaffolding in Instruction

*"[A scaffold] lends consciousness to a child who does not have on his own"* (Bruner, 1986, p. 86)

Scaffolding has been defined as a strategy which involves supporting learners by limiting the complexities of the learning content. In her paper (Dabbagh, 2003) cites definitions of scaffolding provided in (Young, 1993) – "Scaffolding involves supporting novice learners by limiting the complexities of the learning context and gradually removing those limits (a concept known as fading) as learners gain the knowledge, skills and confidence to cope with the full complexity of the context"; and (Jarvela, 1995; Pressley & et al., 1996) – "Assistance to learners is provided on an as-needed basis and as their task competence increases, fading of assistance is gradually administered to allow learners to complete the task independently."

(Stone, 1998) defines scaffolding as a metaphor for the process by which adults or more knowledgeable peers guide children's learning and development. According to (Stone, 1998), "In providing temporary assistance to children as they strive to accomplish a task just out of their competency, adults are said to be providing a scaffold, much like that used by builders in erecting a building" (p. 344). (Wood, Bruner, & Ross, 1976) [as cited in (Stone, 1998)] describe scaffolding as a form of adult assistance "that enables a child or novice to solve a problem, carry out a task or achieve a goal which would be beyond his unassisted efforts" (p. 90).

(Wood et al., 1976) [as cited in (Stone, 1998)] identified six types of assistance that an adult tutor could provide to scaffold learning: (a) recruitment of children's interest, (b) reduction in degrees of freedom, (c) maintaining goal orientation, (d) highlighting critical task features, (e) controlling frustration, and (f) demonstrating idealized solution paths. (Stone, 1998) in referring to (Wood et al., 1976) writes "It is important to note that this list includes (a) perceptual components (e.g. highlighting critical task features), (b) cognitive components (e.g. reduction in degrees of freedom), and (c) affective components (e.g. controlling frustration)."

In her paper (Butler, 1998) describes how the scaffolding metaphor is used in Strategic Content Learning, an instructional approach that promote strategic learning in students with learning disabilities. She writes, "The scaffolding metaphor has made significant contributions to our understanding of the characteristics of effective instruction. Those contributions include an emphasis on important instructional characteristics: (a) support should be flexibly calibrated to meet students' needs; (b) support should be either increased or faded depending on how independently students regulate their learning; (c) support should be provided in the context of a meaningful task; (d) support is best provided by means of interactive dialogues conducted during collaborative problem solving; and (e) rather than breaking tasks into subskills, support should be provided for subskills as they occur in the context of meaningful tasks."

(Hannafin, Hannafin, Land, & Oliver, 1997) have proposed a model of scaffolding in open-ended learning environments. They delineate four categories of scaffolds: (a) Conceptual scaffolding (helps students determine what to consider when solving a problem), (b) Metacognitive scaffolding (supports the underlying processes associated with individual learning management) (c) Procedural scaffolding (helps learners by providing hints on how to utilize available resources and tools), and (d) Strategic scaffolding (provides support for how to utilize strategies).

Based on the 1976 article by (Wood et al., 1976), (Pea & Mills, 2004) has described the processes by which scaffolding is "functioned" for the learner: "1. Channeling and focusing: Reducing the degrees of freedom for the task at hand by providing constraints that increase the likelihood of the learner's effective action; recruiting and focusing attention of the learner by marking relevant task features (in what is otherwise a complex stimulus field), with the result of maintaining directedness of the learner's activity toward task achievement. 2. Modeling: Modeling more advanced solutions to the task." (pg. 432).

## Origins of the Scaffolding Metaphor

The origins of the scaffolding metaphor lie in the social constructivist theoretical tradition. Scaffolding has clear connections with Vygotsky's idea of Zone of Proximal Development. According to (Bull et al., 1999), "When in the zone of proximal development for a particular skill or a piece of information, a learner is ready to learn but lacks certain prerequisites. Scaffolding is an interactive process in which a teacher or facilitator assists such a learner to build a 'structure' to contain and frame the new information" (p. 240).

(Stone, 1998) has pointed out that "Although the initial use of the scaffolding metaphor was largely pragmatic and atheoretical, in subsequent discussion it was increasingly linked with Vygotsky's (1962, 1978) developmental theory. …The implicit link between Vygotsky's ZPD and the scaffolding metaphor was first made explicit by Cazden (1979)" (p. 345).

### Scaffolding and Cognitive Theory

Cognitive theory looks at *understanding* as being determined by the previous experiences of the learner, his past knowledge and the ways in which this information has been stored (memory structures determine how new information will be assimilated or represented). (Bull et al., 1999) have related *understanding* with *scaffolding* as such "To be able to learn from particular information, a learner must have sufficient background knowledge to be able, with help, to start to process the new information into personal knowledge. …When scaffolding is necessary, the teacher should try to minimize the cognitive load by setting the environment conditions so that the student can both recall and use information that he/she already knows to perform most of the task (tie the new material to the old). Therefore the student has only to learn a limited amount of new information to be successful" (p. 242).

### Visual scaffolding

Much research has been done on the role of pictures in text. Pictures can help learning by establishing a setting, contributing to text's coherence and reinforcing the text. (Levin & Mayer, 1993) have proposed seven "C" principles for explaining why pictures facilitate learning – pictures improve student learning from text by making it text more concentrated, compact/concise, concrete, coherent, comprehensible, correspondent, and codable.

(Cuevas, Fiore, & Oser, 2002) have studied how instructional strategies (such as use of diagrams in instruction) in complex task training environments can be used to scaffold learners' cognitive and metacognitive processes, especially for low ability learners. Their findings suggest that incorporating diagrams into training facilitated performance on measures of integrative knowledge (they found no significant effect on measures of declarative knowledge). They write "Diagrams additionally facilitated the development of accurate mental models and significantly improved the instructional efficiency of the training. Finally diagrams effectively scaffold participants' metacognition, improving their metacomprehension accuracy (i.e. their ability to actually monitor their comprehension)" (p. 433). "There are several theories that elucidate why inclusion of illustrations, such as pictures and diagrams leads to better understanding of the presented material and improved retention and application of its concepts. One theory suggests that diagrams repeat the information in the text. …Another interpretation of positive effects of diagrams attributes improved learning to dual coding of the information in memory. Paivio (1971) proposed that verbal and nonverbal (i.e., visual/ spatial) information are processed in separate, functionally distinct, although interconnected, long term memory systems. …Accordingly, presented information using both texts and diagrams activates more than one mechanism of memory…. Therefore, since the information is processed by two distinct mechanisms, encoding is reinforced, and retrieval from memory should be facilitated" (p. 434).

According to (Cuevas et al., 2002) diagrams increase the efficiency of the learner's information processing by decreasing the cognitive load, "Well-designed instructional programs would be expected to increase the efficiency of the learner's information processing, so that fewer cognitive resources are required for task performance after training (Paas & Van Merrienboer, 1993). Within the context of the mental model approach we propose that diagrams may reduce the cognitive load on working memory and attention associated with complex tasks by making structural relations clearer and more transparent (Marcus et al., 1996). Thus, incorporating diagrams into the training would be expected to result in higher instructional efficiency (i.e., higher performance will be achieved with less mental effort exerted.)" (p. 437).

### Visual Scaffolding and Cognitive Theory

(Cuevas et al., 2002) have suggested the Metal model theory as a theory for why diagrams are so effective in instruction. In the Metal model theory thinking is considered equivalent to manipulating internal representations stored in the mind. According to (Cuevas et al., 2002), diagrams may serve to scaffold the development of mental models.

## Research Hypothesis and Problem Statement

### Research Hypothesis

It is hypothesized that *visual scaffolding* used to complement *animated* sequences would serve to emphasize the critical attributes to be learned, thereby reducing the cognitive load. This will, in turn, enable students to process information more effectively. The visual scaffolds designed to complement animation would function to facilitate generative and metacognitive processes necessary to facilitate the comprehension of higher level learning objectives and the transfer of information from short term into long term memory. This notion of using scaffolding to provide procedural guidance to more effectively process the information acquisition has been supported by McLoughlin & Oliver (1999).

### Problem Statement

Dabbagh (2003, p.42) has hypothesized that "low and high scaffolding are highly correlated with the type of instructional strategies implemented in a learning environment." The purpose of this study was to examine the instructional effects of scaffolding in facilitating higher level performance outcomes. Specifically, the focus of this study was to examine the degree to which two levels of visual scaffolding strategies (simple and complex), used to complement animated instruction, facilitated achievement of higher level performance outcomes as measured by four criterion tests.

## Instructional Content and Dependent Measures

### Instructional Content

The instructional content used in the study is related to the physiology and functions of the human heart. This content was selected because it provided a hierarchy of learning objectives (from facts to problem solving). Problem solving required learning the terminology of the human heart, location of the parts and their respective functions, and positions during the systolic and diastolic phases. The dependent variables in the study were achievement on test measuring different levels of learning. Achievement was measured in terms of facts, concepts, rules/procedures and comprehension. A 20-item test was developed for each of these criterion measures. Average Kuder-Richardson Formula-20 reliability coefficients from a random sampling of studies (Dwyer, 1978) are: .83 for the Terminology Test, .81 for the Identification Test, .83 for the Drawing Test, .77 for the Comprehension Test, and .92 for the Total Test. Following are descriptions of the criterion measures employed, (Ibid. 45-47).

### Dependent Measures

**Drawing Test.** The objective of the drawing test was 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.

**Identification Test.** The objective of the identification test was to evaluate student ability to identify parts or positions of an object. This multiple-choice test required students to identify the numbered parts on a detailed drawing of a heart. Each part of the heart, which had been discussed in the presentation, was numbered on a 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.

**Terminology Test.** This 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 which have an understanding of the basic elements as a prerequisite to the learning of concepts, rules, and principles.

**Comprehension Test.** Given the location of certain parts of the heart at a particular moment of its functioning, the student was asked to determine the position of other specified parts or positions of other specified parts of 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. 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.

**Total Test Score.** The items contained in the individual criterion tests were combined into a composite test score. The purpose was to measure total achievement of the objectives presented in the instructional unit.

## Research Methodology

Two pilot studies were conducted to develop the instruction that is used as the control treatment in this study.

### Pilot Study 1

In the first pilot study, programmed instruction focusing on facts and concepts necessary for higher order learning was prepared and tested. The rationale for developing the programmed instruction was a hypothesis from (Dwyer, 2003): "The ineffectiveness of animation in facilitating higher level cognitive functions may be because learners do not possess the prerequisite facts and concepts to use in constructing rules and principles necessary for higher order comprehension." Students were presented with this instruction followed by the heart content tests. Their scores on the drawing and identification test (facts and concepts) were found to be significantly better than those students that took regular instruction (in previous studies). Students' scores on the terminology and comprehension tests (rules and procedures) were still low. These results showed that although programmed instruction was effective in transfer of facts and concepts; rules and procedures still needed attention.

### Pilot Study 2

Based on item analysis of the identification and comprehension test (rules and procedures), points in the instruction that needed improvement were identified. Animation (developed using Macromedia Flash) was designed and placed at these points. A second pilot study with 138 students and three treatments: Condition A (Control group: regular instruction), Condition B (programmed instruction), and Condition C (programmed instruction + animation) was conducted. Results from this study *again* showed that the programmed instruction was effective in transferring facts and concepts. It should be noted that no significant gains in the terminology and comprehension tests (rules and procedures) were obtained in Condition C. (Table 1a and 1b)

An item analysis of the identification and comprehension test for Condition C in the second pilot study was conducted to identify points in the instruction that needed further improvement. Simple and complex scaffolding was designed and placed at these points.

### Development of Simple and Complex Scaffolding Treatment

We have used the cognitive model to define simple and complex scaffolding as such – simple scaffolding instigates lower levels of cognitive processing in learners as compared to complex scaffolding, which instigates higher levels of cognitive processing in the learner.

Another dimension along which scaffolding can be differentiated is suggested by (Azevado et al, 2004). (Azevado et al, 2004) examined the role of different scaffolding interventions in facilitating students' shift in mental models. They found adaptive scaffolding (access to a tutor and specific goals) facilitated shift in a learner's mental models significantly more than fixed scaffolding (access only to specific goals).

Note: It has been the experience of the author that instruction that uses complex scaffolding is more challenging from an instructional design and development point of view. For example simple scaffolding for this study is designed using simple HTML forms, whereas the complex scaffolding is designed with Java applets.

### Visual Scaffolding using *Transformational* (Mnemonic) Function of Images

The use of diagrams as mnemonics to provide scaffolding is supported by research. (Levin, 1981) has delineated five functions that pictures serve in text processing: decorational, representational, organizational, interpretational and transformational. According to (Carney & Levin, 2002) decorational pictures "simply decorate the page, bearing little or no relationship to the text content"; representational pictures "mirror part or all of the text content and are by far the most commonly used type of illustration"; organizational pictures "provide a useful structural framework for the text content"; interpretational pictures "help to clarify difficult text"; and *transformational* pictures "include systematic mnemonic (memory enhancing) components that are designed to improve a reader's recall of text information". It is worth noting that in theory research (Carney & Levin, 2002)found that "Purely decorational pictures exhibited virtually no beneficial text-learning effects, whereas the remaining effect sizes ranged from moderate benefits (for representational pictures) to quite substantial benefits (for transformational pictures)" (pg. 7-8).

Moreover, on the basis of (Levin et al, 1990), (Carney & Levin, 2002) suggest the following about the *interpretational* function of pictures in instruction, "Of particular interest to these investigators was whether mnemonic illustrations could enable students go beyond the information given and assist them in performing higher order cognitive application tasks such as those involving inference, problem solving, and analogical and syllogistic reasoning based on the botany content" (pg. 18). Further "Combined with separate mnemonic illustrations for solidifying unfamiliar terminology and definitions, the pictorial mnemonomy was found to be a potent facilitator of students' information reconstruction and application performance both on immediate tests and on delayed tests up to 2 months later" (pg. 18). Finally, according to (Carney & Levin, 2002), (Atkinson et al., 1999) have argued that "that the ready access to information that mnemonic strategies afford can facilitate students' acquisition of higher order concepts and skills" (pg. 20).

## Results

For the present study, there conditions were used: Condition A (programmed instruction + animation), Condition B (programmed instruction + animation + simple scaffolding), and Condition C (programmed instruction + animation + complex scaffolding). Dependent measures were scores achieved on the drawing, identification, terminology, and comprehension tests. 87 students were randomly assigned to the three treatment groups. Data from each criterion measure was analyzed collectively and individually to comprehensively examine the contributions of visual scaffolding in complementing animation. No significant differences in scores were found. (Table 2a and 2b)

## Discussion

According to (Mayer & Moreno, 2003), a potential problem of multimedia learning environments is that processing demands evoked by the learning task (words and pictures) may exceed the processing capacity of cognitive systems. Such a situation is called *cognitive overload*. (Mayer et al, 2003) describe three kinds of cognitive demands: (1) *essential processing* (cognitive processes that are required to make sense of the presented material); (2) *incidental processing* (cognitive processes that are due to the design of the learning task); and (3) *representational holding* (cognitive resources used to hold a metal model in working memory). Cognitive overload occurs when the sum of these processing demands exceeds the processing capacity of the learner's cognitive system.

The insignificant results of this study may be explained by the increase in cognitive load that visual scaffolding and animation put on the learners. In other words, positive effect of visual scaffolding and animation may be cancelled by an increase in task complexity.

## Conclusions

The results of the analyses indicated that specific types of visual scaffolding (simple and complex) are important variables for facilitating specific types of performance outcomes. Initial interpretation of the results indicated that visual scaffolding strategies, specifically designed, developed and positioned, have the potential for focusing and illustrating procedural understanding thereby reducing the cognitive load associated with the higher processing levels in the knowledge acquisition domain.

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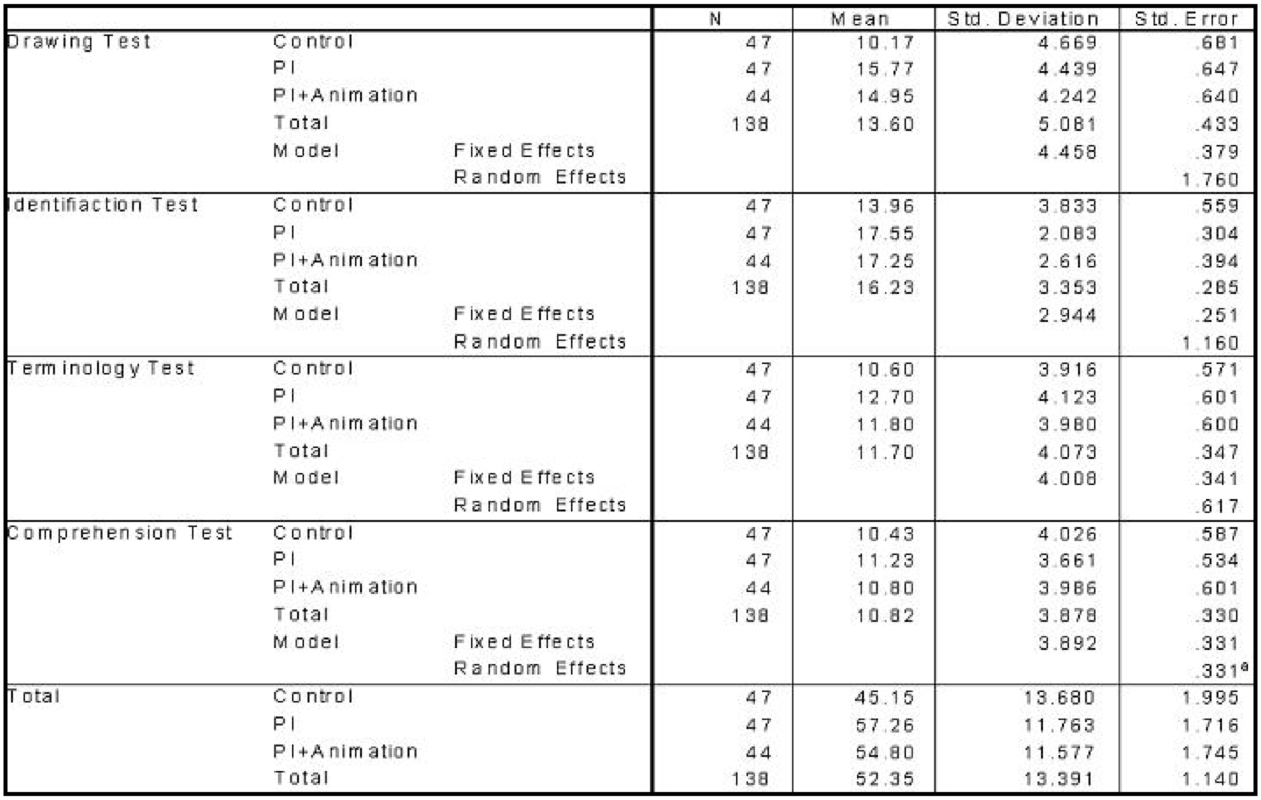
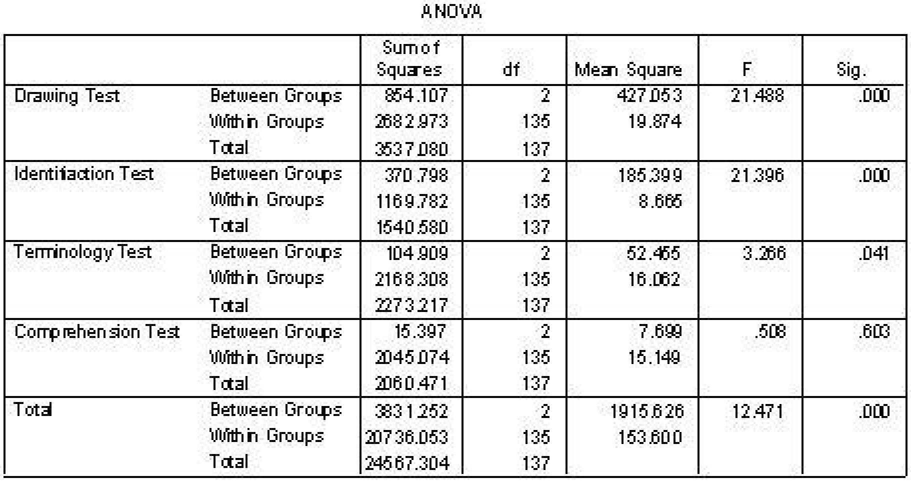
# Tables



| | | | N | Mean | Std. Deviation | Std. Error |
|---|---|---|---|---|---|---|
| Drawing Test | Control | | 47 | 10.17 | 4.669 | .681 |
| | PI | | 47 | 15.77 | 4.439 | .647 |
| | PI+Animation | | 44 | 14.95 | 4.242 | .640 |
| | Total | | 138 | 13.60 | 5.081 | .433 |
| | Model | Fixed Effects | | | 4.458 | .379 |
| | | Random Effects | | | | 1.760 |
| Identifiaction Test | Control | | 47 | 13.96 | 3.833 | .559 |
| | PI | | 47 | 17.55 | 2.083 | .304 |
| | PI+Animation | | 44 | 17.25 | 2.616 | .394 |
| | Total | | 138 | 16.23 | 3.353 | .285 |
| | Model | Fixed Effects | | | 2.944 | .251 |
| | | Random Effects | | | | 1.160 |
| Terminology Test | Control | | 47 | 10.60 | 3.916 | .571 |
| | PI | | 47 | 12.70 | 4.123 | .601 |
| | PI+Animation | | 44 | 11.80 | 3.980 | .600 |
| | Total | | 138 | 11.70 | 4.073 | .347 |
| | Model | Fixed Effects | | | 4.008 | .341 |
| | | Random Effects | | | | .617 |
| Comprehension Test | Control | | 47 | 10.43 | 4.026 | .587 |
| | PI | | 47 | 11.23 | 3.661 | .534 |
| | PI+Animation | | 44 | 10.80 | 3.986 | .601 |
| | Total | | 138 | 10.82 | 3.878 | .330 |
| | Model | Fixed Effects | | | 3.892 | .331 |
| | | Random Effects | | | | .331[a] |
| Total | Control | | 47 | 45.15 | 13.680 | 1.995 |
| | PI | | 47 | 57.26 | 11.763 | 1.716 |
| | PI+Animation | | 44 | 54.80 | 11.577 | 1.745 |
| | Total | | 138 | 52.35 | 13.391 | 1.140 |

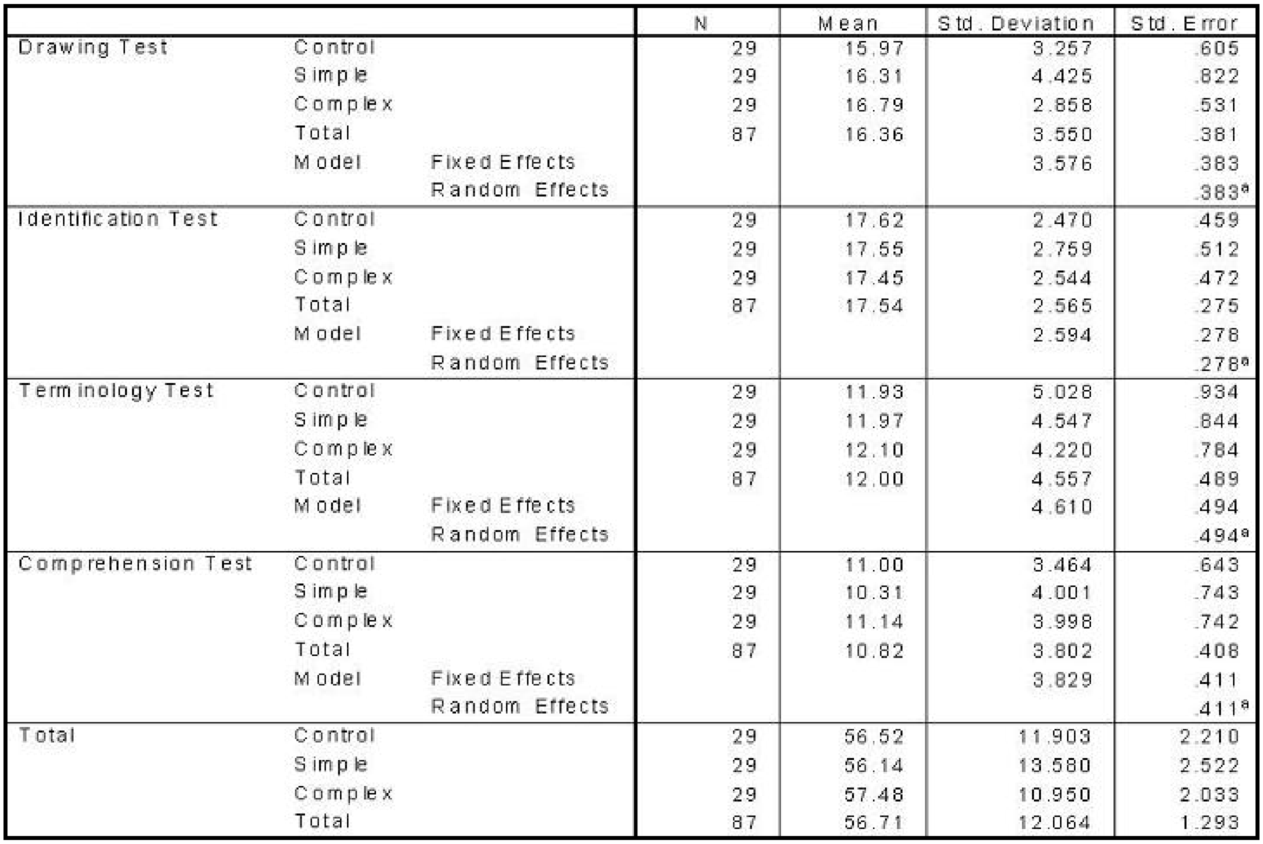
Table 1a



ANOVA

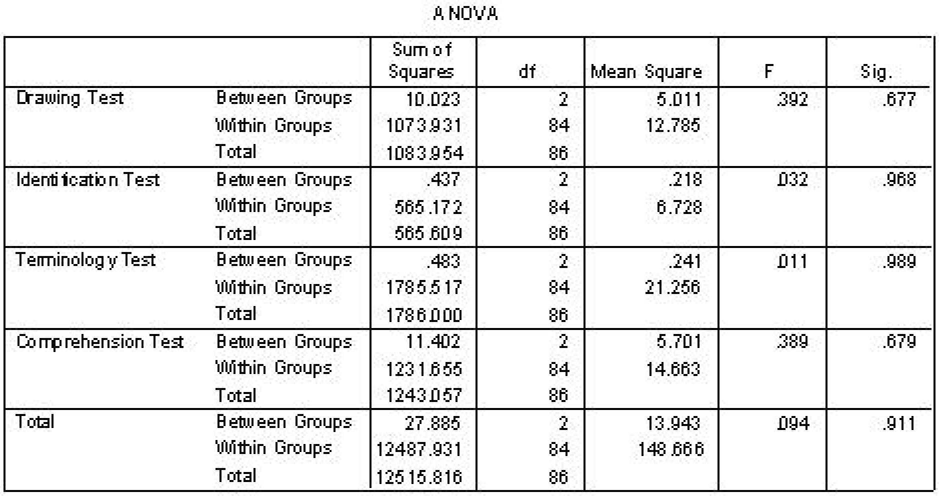
| | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| Drawing Test | Between Groups | 854.107 | 2 | 427.053 | 21.488 | .000 |
| | Within Groups | 2682.973 | 135 | 19.874 | | |
| | Total | 3537.080 | 137 | | | |
| Identifiaction Test | Between Groups | 370.798 | 2 | 185.399 | 21.396 | .000 |
| | Within Groups | 1169.782 | 135 | 8.665 | | |
| | Total | 1540.580 | 137 | | | |
| Terminology Test | Between Groups | 104.909 | 2 | 52.455 | 3.266 | .041 |
| | Within Groups | 2168.308 | 135 | 16.062 | | |
| | Total | 2273.217 | 137 | | | |
| Comprehension Test | Between Groups | 15.397 | 2 | 7.699 | .508 | .603 |
| | Within Groups | 2045.074 | 135 | 15.149 | | |
| | Total | 2060.471 | 137 | | | |
| Total | Between Groups | 3831.252 | 2 | 1915.626 | 12.471 | .000 |
| | Within Groups | 20736.053 | 135 | 153.600 | | |
| | Total | 24567.304 | 137 | | | |

Table 1b



| | | | N | Mean | Std. Deviation | Std. Error |
|---|---|---|---|---|---|---|
| Drawing Test | Control | | 29 | 15.97 | 3.257 | .605 |
| | Simple | | 29 | 16.31 | 4.425 | .822 |
| | Complex | | 29 | 16.79 | 2.858 | .531 |
| | Total | | 87 | 16.36 | 3.550 | .381 |
| | Model | Fixed Effects | | | 3.576 | .383 |
| | | Random Effects | | | | .383[a] |
| Identification Test | Control | | 29 | 17.62 | 2.470 | .459 |
| | Simple | | 29 | 17.55 | 2.759 | .512 |
| | Complex | | 29 | 17.45 | 2.544 | .472 |
| | Total | | 87 | 17.54 | 2.565 | .275 |
| | Model | Fixed Effects | | | 2.594 | .278 |
| | | Random Effects | | | | .278[a] |
| Terminology Test | Control | | 29 | 11.93 | 5.028 | .934 |
| | Simple | | 29 | 11.97 | 4.547 | .844 |
| | Complex | | 29 | 12.10 | 4.220 | .784 |
| | Total | | 87 | 12.00 | 4.557 | .489 |
| | Model | Fixed Effects | | | 4.610 | .494 |
| | | Random Effects | | | | .494[a] |
| Comprehension Test | Control | | 29 | 11.00 | 3.464 | .643 |
| | Simple | | 29 | 10.31 | 4.001 | .743 |
| | Complex | | 29 | 11.14 | 3.998 | .742 |
| | Total | | 87 | 10.82 | 3.802 | .408 |
| | Model | Fixed Effects | | | 3.829 | .411 |
| | | Random Effects | | | | .411[a] |
| Total | Control | | 29 | 56.52 | 11.903 | 2.210 |
| | Simple | | 29 | 56.14 | 13.580 | 2.522 |
| | Complex | | 29 | 57.48 | 10.950 | 2.033 |
| | Total | | 87 | 56.71 | 12.064 | 1.293 |

Table 2a



ANOVA

| | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| Drawing Test | Between Groups | 10.023 | 2 | 5.011 | .392 | .677 |
| | Within Groups | 1073.931 | 84 | 12.785 | | |
| | Total | 1083.954 | 86 | | | |
| Identification Test | Between Groups | .437 | 2 | .218 | .032 | .968 |
| | Within Groups | 565.172 | 84 | 6.728 | | |
| | Total | 565.609 | 86 | | | |
| Terminology Test | Between Groups | .483 | 2 | .241 | .011 | .989 |
| | Within Groups | 1785.517 | 84 | 21.256 | | |
| | Total | 1786.000 | 86 | | | |
| Comprehension Test | Between Groups | 11.402 | 2 | 5.701 | .389 | .679 |
| | Within Groups | 1231.655 | 84 | 14.663 | | |
| | Total | 1243.057 | 86 | | | |
| Total | Between Groups | 27.885 | 2 | 13.943 | .094 | .911 |
| | Within Groups | 12487.931 | 84 | 148.666 | | |
| | Total | 12515.816 | 86 | | | |

Table 2b