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The effects of goal message and goal orientation on learning in a Web-based tutorial

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The Effects of Goal Message and Goal Orientation on Learning in a Web-Based Tutorial

by

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Dedication

To my wife Kathy, this taiken o loue. You made it possible in every way.

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ABSTRACT

The current study investigates instructional design factors that can be manipulated to enhance learner motivation. A goal-based approach to enhancing motivation is discussed, along with current theory concerning the *goal orientation* an individual learner brings to an instructional situation. The efficacy of Prospect Theory as a cognitive mechanism underlying the valuation of effort toward a goal is discussed, and an experiment is presented in which goal messaging is manipulated based on the predictions of Prospect Theory as well as Goal Setting Theory. A Web-based tutorial consisting of ten sections of text, each with a recall test, was used. An ability goal orientation was found to impact section quiz scores. Both goal message framing and goal difficulty level were found to interact with an ability goal orientation to impact performance on section quizzes. A learning goal orientation was found to interact with goal difficulty to impact section quiz scores. The author concludes that while the study supports the use of goal messaging to enhance motivation, such manipulations by educators must be made in light of the goal orientations a learner brings to the instructional setting.

Chapter One: Introduction

Current theories of cognition (e.g. Anderson, et al. 2004) hold that the single most important factor in learning is the time and effort a learner invests in the learning task. Further, instructional method alone cannot act as a "magic bullet" for learning (Anderson & Schun, 2001), and even the most well conceived and executed instructional method is of marginal value for unmotivated students. Persistence and effort, in other words, are critical factors in the acquisition of knowledge. In order to increase the chance that students will stay engaged in the learning task, teachers, instructional designers, curriculum developers, and other professionals involved in the creation of learning environments must have an understanding of instructional design factors that impact the motivation to learn.

As computer-mediated forms of instruction become more commonplace, the importance of understanding the nature of motivation in this environment will grow. As novelty effects wear off with continued exposure, developers of computer-mediated forms of instruction will face an increasing challenge to motivate learners and sustain their attention and effort throughout an instructional program (Song & Keller, 2001).

A review of the instructional technology literature, however, reveals a relative paucity of attention paid to purely motivational factors in instructional design. The exception to this is the work of Keller (see Keller, 1987a for a review). Keller (1979) notes the lack of attention paid to motivational issues in general within the instructional technology literature, also noting (Keller, 1987b) the lack of "macro" theories addressing the issue of *how to create* instruction to stimulate the motivation to learn. In response to this, he developed a "macro" theory of motivation and instruction and an instructional design process model, Attention, Relevance, Confidence, and Satisfaction (ARCS), based on it (Keller; 1979, 1987a).

The ARCS model is based on the social learning theory perspective that motivation results from the interaction of the learner with the environment (Keller, 1979), and takes a holistic approach to enhancing it. To implement ARCS, the instructional designer must embark on a multi-step analysis of the motivational characteristics of the learners and the existing instructional materials in order to begin selecting motivational tactics to add to the instruction. Specifically, ARCS seeks to address the motivational factors associated with what Keller (1987a) identifies as the "four major conditions that have to be met for people to become and remain motivated" (p.3), which he identifies as getting and sustaining attention, relevance to personal needs, confidence in the ability to succeed, and satisfaction with accomplishments.

Rather than providing general guidelines or straightforward prescriptions for the enhancement of motivation in most situations, ARCS is a relatively laborious endeavor that few educators will undertake (even if an enhancement of student motivation would result). Further, ARCS is derived from expectancy-value models of motivation (e.g. Vroom, 1964; Porter & Lawler, 1968). These models hold that motivation is determined primarily by the *expectancy* that a task can be accomplished and that effort towards it will "pay off", and the *value* an individual places on the outcome. More recent theories of motivation, particularly the goal-setting theory (GST) of Locke and Latham (see Locke & Latham, 2002, for a review) have subsumed or replaced the earlier expectancy-value models.

Instead of attempting to build a broad or "macro" theory of motivation and work top-down to specific behavioral contexts, Lock and Latham began with a couple of basic assumptions about human action – it is purposeful, and the idea of and desire for an end state *causes* the action. This led to a focus on *goals* as regulators of action, and a long series of laboratory and field studies examining those aspects of goals that lead to changes in behavior. The majority of this work was done in American workplace environments, and asked practical questions related to enhancing performance outcomes in those environments.

ARCS approaches motivational enhancement from a cover-all-zones strategy (If I might be allowed a basketball metaphor here). Keller (1987a) clearly intends his four ARCS conditions to "subsume many of the specific concepts and variables that characterize human motivation" (p. 2). While there is little doubt that Keller's four conditions impact a general motivational process or set of processes, from a practical perspective it is too cumbersome a task to successful manipulate all of them within the context of all but the most clearly-defined instructional missions with the most well-understood audience of learners. Also, as Covington (2000) notes, motivation itself is a concept not fully understood, and one that has produced many differing perspectives in the literature. From both a practical and theoretical perspective, the ARCS approach to motivational enhancement is simply too broad.

Locke and Latham's GST approach, on the other hand, is more run-and-gun. Within this approach, motivation can best be thought of as an emergent property of the movement of an individual from an initial state to a goal state. Contrary to Keller's approach, the focus is not on enhancing motivation per se, but rather on enhancing performance by manipulating the outcome goal. While a causal attribution can be made that *a* motivational phenomenon led to an increase or decrease in performance, an explanatory model of such phenomena is not critical. An outcome goal is a quantifiable and definable entity, and by understanding the outcome goal as the regulator of action, successful performance enhancement schemes can be developed.

From this perspective, the goal-as-regulator of action gives the instructional designer a manipulatable environmental factor on which to hang his or her motivational hat. Although certainly not the only desirable outcome, a minimum score on an objective knowledge assessment following an instructional program, for example, is an easily-definable instructional goal that appears quite analogous to the workplace productivity goals on which GST is based. The implication of this is clear — by applying the principles of GST to the learning environment, the instructional designer can improve performance by enhancing motivation.

However, although the efficacy of GST has been demonstrated in many studies, it has not been tested within a strictly educational or instructional context, and its impact on performance within a learning environment is not clear. While the similarities between performance in an instructional environment and performance in the workplace environment seem substantial, there are important differences that must be considered. Primarily, GST has typically been tested with either work groups or individuals working toward goals assigned by a superior. Within the workplace environment, there is nothing particularly novel about this arrangement.

Although this may differ somewhat between settings and learner populations, students bring a host of attitudes, pre-dispositions, habits, beliefs, etc. with them to the learning environment, and some of these attributes will certainly bear on the impact of goals. While the same could be said of the work environment, the performance goal milieu in the workplace seems inherently simpler – the boss sets the goal, the worker's job is to reach the goal as efficiently as possible. This highlights another potential difference - who sets instructional goals? Do the students bring goals with them, do they inherit goals from the instructional environment, or is it some combination of both? The individual differences, then, between students regarding instructional goals need to be taken into account when considering the impact of manipulations of those goals.

A great deal of research (see Covington, 2000, for a review) on academic achievement motivation from a social-cognitive perspective over the last 20 years or so provides a window on these processes. Researchers have identified specific *goal orientations* a student brings with him or her to the learning environment. Meece, Blumenfeld, and Hoyle (1988) define goal orientations as a set of behavioral intentions that determine how students approach and engage in learning activities. Generally, goal orientations come in two basic flavors, based on the type of goal at the motivational root of the learner:

1. *Learning goals* focus on content mastery; and
2. *Performance goals* focus on an objective display of ability, i.e. achieving a high exam grade.

In addition, as demonstrated by Elliot and Harackiewicz (1996), and Harackiewicz and Elliot (1998), goals of both types can be externally mediated or assigned within the task environment. Although many researchers (as noted by Pintrich, 2000) have associated learning goals with a more adaptive pattern of instructional engagement and performance goals with a less adaptive pattern, others (i.e. Grant & Dweck, 2003) have not found such clear distinctions. So while there are clearly differences between the nature of goals in the workplace environment and goals in the instructional environment, there exists a rich body of literature with the potential to inform the instructional designer of those differences.

Another important consideration concerning an application of GST to an instructional environment involves the critical factors of effort and persistence. As noted earlier, these things are at the heart of an effective learning process, and thus factors the instructional designer should seek to enhance. A key issue, then, is to gain an understanding of how goals influence the value a learner attaches to effort exerted toward reaching a given goal. If the value of this effort could be enhanced through a manipulation of a goal itself, the instructional designer would have a powerful tool for the enhancement of learning.

Heath, Larrick, and Wu (1999) present a compelling argument that Prospect Theory (Kahneman & Tversky, 1979) provides a description of the cognitive process underlying the valuing of effort toward a goal within a GST context. Essentially, they argue that a goal acts as a reference point in Prospect Theory's value function, and that this value function can thus be used to predict the value of effort above and below, and near and far, from a goal. The implication of this to an instructional environment is straightforward – the instructional designer should use this value function to set goals that maximize the value of effort throughout the instructional program.

If a goal acts as a reference point in the value function, then according to Prospect Theory, the value of effort increases rapidly as one approaches a goal, then quickly diminishes as the goal is surpassed. Also, effort exerted to overcome a deficit is valued more highly than effort exerted to maintain a surplus, even if a quantitative measure of both positions is the same. In other words, the psychological perception of being below a goal is a more powerful motivator than the perception of being above a goal. Suppose, for example, two students each need to score 90% correct on a 100-item exam in order to earn an "A" on it. One student is told that he or she starts the exam with 100 points, and will lose a point for each incorrect answer. The other student is told that he or she starts the exam with 0 points and will earn a point for each correct answer. According to Prospect Theory, the value of effort will be greater for the latter student, who finds himself or herself below the goal and must therefore work to make up a deficit.

Statement of the Problem

Currently, instructional designers have little practical guidance in the important task of enhancing learner motivation. In learning situations without a live teacher to actively attend to the motivational requirements of the environment (i.e. computer-mediated), less-than-optimal instruction will almost certainly result. Thus instructional design, particularly for computer-mediated environments, would benefit from an understanding of specific factors in the learning environment that can be manipulated to enhance learner motivation.

Research Questions and Hypotheses

The current study seeks to investigate the impact of *goal messaging* on learning within a computer-mediated learning environment in an effort to enhance effort and persistence in this environment. Goal messaging is defined here as a statement of a desired performance outcome made to the learner within the learning environment (which is to say made *by* the learning environment). It is predicted that assigning goals at the beginning of the instructional program will influence performance as measured by an objective knowledge assessment at the end of the instructional program. Also, it is predicted that the effects of these goals are predicted by goal-setting theory (Locke & Latham, 1990) – difficult goals will result in higher performance than easy goals. Stated more formally:

H1: A difficult, challenging goal will lead to higher scores on an objective knowledge assessment than an "easy" goal, and both of these types of goals will lead to better performance than a goal that is so difficult it that it is perceived to be beyond reach.

As predicted by Prospect Theory, *framing* of the goal message will impact performance such that participants who must work to make up a deficit (below-goal frame) will demonstrate higher performance than those working to maintain a current position or avoid losing ground (above goal frame). Thus, it is predicted that:

H2: Performance feedback stated in terms of gaining points towards a stated goal score on an objective knowledge assessment will lead to higher performance levels than performance feedback stated in terms of losing points.

Finally, the goal orientation that students bring with them to the learning environment will interact with goal message manipulations. Specifically, students with a strong performance goal orientation but weak learning goal orientation will be most affected by goal messaging, and students with a strong learning goal orientation and weak performance goal orientation will be least affected. Thus, it is predicted that:

H3a: Students scoring high on the performance goal subscales of the Achievement Goal Inventory (AGI) (Grant & Dweck, 2003) and low on the learning goal subscale of the AGI will exhibit the strongest influence of goal messaging.

H3b: Students scoring low on the performance goal subscales of the AGI and high on the learning goal subscales will exhibit the weakest influence of goal messaging.

Assumptions, Limitations, and Delimitations

This is an empirical study, and as such makes a conscious trade-off between internal validity and generalizability. In an effort to mitigate threats to generalizability the experimental tutorial was administered during regular class periods to students enrolled in those classes, and consists of content normally covered in those classes. It will be up to future research to replicate the current study with other student populations under additional conditions.

Another issue related to external validity is the operationalization of the measurement of learning as a score on an objective knowledge assessment, specifically a multiple-choice test. The current study does in fact rest on the assumption that such an assessment provides an authentic and generalizable measure of learning, but certainly not to the extent that similar studies with additional measures of learning aren't indicated.

As this study represents an initial investigation of the impact of goal-setting in an instructional environment, the high level of experimental control offered by the current approach outweighs the potential delimitations. It will be up to future research to investigate these issues in additional contexts and/or with different research designs.

Definitions

Motivation. This paper defines the general construct of *motivation* as an emergent property of the movement of an individual from one goal state to another. There is no attempt to define or describe it in terms of any specific collection of underlying processes. This is not to say that an assumption is made that no underlying processes that might be termed "motivational" exist. Rather, the current study does not consider "motivation" as a holistic or unitary construct or behavioral phenomenon, and does not attempt to operationalize it as such. From this perspective, the term motivation is used in a very general (and purposefully loose) sense to refer to any and all processes, constructs, events, etc. that influence the movement of an individual from one goal state to another.

Intrinsic Motivation. The term *intrinsic motivation* refers to the specific interest and enjoyment a learner exhibits toward a learning task. It may also be described as *task interest*.

Chunk. A memory structure in which information is stored as a single meaningful unit.

Chunking. The learning mechanism leading to the acquisition of *chunks.*

Learning goal. An instructional outcome goal for which the focus is on content mastery and an increase in knowledge.

Performance goal. An instructional outcome goal for which the focus is on a quantified display of ability.

Chapter Two: Literature Review

In a broad sense, the importance of "motivation" to the educational process seems so obvious as to be almost trivial to mention. However, educational researchers have historically been hard pressed to define it consistently. In the way of analogy, once while sitting around a campfire as a child, one of the other children in the group asked what the word "motivation" meant. The group leader, an older man with a thick North Carolina accent, and not given to verbose academic discourse, stroked his beard for a minute or two then proceeded to tell a story. It seems he had a moonshine-drinking Uncle Joe who no one could seem to talk out of the jug. Late one night Uncle Joe was stumbling through a graveyard when he fell into a recently-dug grave. Uncle Joe laid there for a while, flat on his back in a drunken stupor, until he heard a voice right under him say "get off me!" Whatever it was that made Uncle Joe jump six feet in the air and straight out of that grave, and swear off white lightening from that moment on, was *motivation*.

And so it is that we approach the idea of motivation within instructional settings: we know what it *does*, even if we can't quite define what it *is*. As stated by former Secretary of Education Terrel H. Bell, "There are three things to remember about education. The first one is motivation. The second one is motivation. The third one is motivation. (Ames, 1990)." While the concept of motivation is said to stand "…at the center of the educational enterprise (Covington, 2000, p. 171)," the term as used by psychological and educational researchers is characterized as conceptually vague (Murphy & Alexander, 2000).

This paper consciously chooses to sidestep this definitional problem and instead focus on concrete facets of the learning environment that can be manipulated by an educator to cause learners to invest more effort in the learning task. To this end, the first part of this literature review will explore why effort is critical, and why instructional method alone cannot provide a "magic bullet" for learning (Anderson & Schun, 2001). Next, I discuss current theory and practice within the instructional technology literature related to the enhancement of motivation. I will then discuss goal-setting theory (e.g. Locke & Latham, 1990) and argue for its efficacy within an instructional context. Also, I will present Prospect Theory (Kahneman & Tverskey, 1979) as a model for the evaluation of effort toward a goal, and the potential usefulness of this to instructional designers. Finally, I review the goal orientation literature (e.g. Grant & Dweck, 2003), and discuss what it brings to bear on goal-setting theory within an instructional context.

Why Learner Effort is Critical

Unified theories of cognition, such as Newell and colleagues' Soar (Newell, 1990) and Anderson and colleagues' ACT-R (Anderson, et al. 2004), attempt to model human cognition in terms of relatively simple processes that interact to produce the behavioral complexity we observe. Rather than focus on a single cognitive function, such as list learning, these theories seek to incorporate findings from the entire spectrum of psychological and neuroscience research into a broad theory of cognition by integrating cognitive subcomponents into a whole. As learning in a school context, by its nature, involves the integrated workings of a variety of cognitive skills, these theories offer important guidance as to what is most critical in the overall learning process.

Soar and ACT-R have developed separately over many years, and each has undergone successive substantial revisions in that time. While Soar and ACT-R posit different mechanisms and organizational structures for memory and the *chunking* process, the two make strikingly similar predictions regarding human learning – it only comes through practice over time, and there is no undiscovered shortcut or secret technique for avoiding this. From this perspective the single most important factor in learning is the time and effort a learner invests in the learning task.

Anderson and Schun (2000) discuss in detail the implications of ACT-R for educators, and conclude that instructional method alone cannot act as a "magic bullet" for learning. ACT-R holds that the basic information processing step which moves the individual toward a problem solution is the firing of a production rule causing the retrieval of a piece of declarative knowledge. A production rule is a discrete piece of procedural knowledge, i.e. "if the goal is to add n1 and n2 in a column and n1 + n2 = n3, then set as a subgoal to write n3 in that column (Anderson & Schun, 2000, p. 4)." In this example, n1 + n2 = n3 is a piece of declarative knowledge (a *chunk*) retrieved by the production rule. The speed and accuracy with which this information processing step occurs is determined by the level of activation of the chunks being retrieved, and the strength of the production rule. The level of activation results from both the *base-level activation* (resulting from the amount of previous learning) and *associative activation* (resulting from the associativeness to the current context).

Production strength and activation levels increase from continued use through practice. As contextual association is important for declarative knowledge activation, this practice must occur within the context in which the information processing step will occur.

This theme is seen throughout ACT-R (Anderson, et al. 2004) – regardless of the method of encoding, knowledge structures are available for use only to the extent that they have adequate activation levels or have previously produced accurate results, and these things come only from practice.

In the case of Soar, Newell (1990) posits a chunking process at the heart of all learning. Chunking happens automatically, but is an experience-based mechanism, requiring the individual to engage the environment in an effortful, goal-based process. Chunking, and thus learning, occurs through active engagement in problem solving.

All performance tasks are cast as problem spaces to be worked through. Long-term memory is conceptualized as a recognition memory in which productions form the contents. Unlike the activation process of ACT-R, however, in Soar productions are brought into working memory through search and pattern recognition. A decision process selects from the productions in working memory, decides what operation to perform, and whether the task is then accomplished. If the task cannot be accomplished through the use of productions in working memory an *impasse* occurs, which leads to the creation of a subgoal to acquire the missing knowledge.

Chunking occurs when an impasse is resolved, and the productions that lead to the creation of the subgoal and the resolution of the impasse are stored in long-term memory. When a similar task is encountered in the future, these productions will be pattern matched and pulled into working memory, thus avoiding an impasse. Thus, in Soar chunking (and therefore learning) occurs through engagement with the environment and effortful action toward a goal. Performance improves as the number and breadth of available productions in long-term memory increases, and this only happens by engaging in active task resolution.

The message to be taken from both Soar and ACT-R by the educator is clear - even the most well conceived and executed instructional method is of marginal value for unmotivated students. Persistence and effort are critical factors in the acquisition of knowledge, and getting and keeping students engaged in an effortful learning process is a fundamental task of anyone involved in instruction.

With the increasing use and importance of computer-mediated learning environments it likewise becomes increasingly important to understand the nature of motivation in these environments. As noted by Keller and Song (2001), novelty effects will certainly wear off with continued exposure, and developers of computer-mediated forms of instruction will face an increasing challenge to motivate learners and sustain their attention and effort throughout an instructional program.

Current Instructional Design Approaches to Motivation

A review of the instructional technology literature, however, reveals that little attention has been paid to purely motivational factors in instructional design. As noted by Means, Jonassen, and Dwyer (1997), the sole exception to this appears to be Keller's ARCS model of motivational design (Keller, 1987), which provides a process-model approach to including motivational factors in instruction, based on Keller's (1979) own theory of motivation.

Keller (1979) notes the lack of attention given to the study of motivation in instruction, and the lack of development of motivation-enhancing instructional technology. Keller (1979) bases his motivational theory on the expectancy-value theories of motivation (e.g. Vroom, 1964; Porter & Lawler, 1968), particularly that of Porter and Lawler (1968). In general, these models hold that motivation is determined primarily by the *expectancy* that a task can be accomplished and effort towards it will "pay off", and the *value* an individual places on the outcome. From this perspective, motivation is conceptualized as a "multiplicative function (Keller, 1979, p. 28)" of expectancy and value. With regards to value, an individual makes choices for one type of outcome or goal over others from the collection of available outcomes. Expectancy refers to the explicit subjective probability of success at accomplishing a particular goal if one were to attempt it.

It is important to note that Keller (1979) defines motivation as *effort exerted* toward reaching an instructional goal, and ultimately designs ARCS to enhance this specific factor. Although one could view this definition as a rather obvious necessity when the ultimate goal is to define a process model for enhancing motivation, it nonetheless establishes a framework from which to approach the issue regardless of one's underlying theory of motivation.

To develop ARCS, Keller (1987a) expands the expectancy-value approach into four conceptual categories that "subsume many of the specific concepts and variables that characterize human motivation (p. 2)." Keller breaks down *value* into two categories – *interest* and *relevance.* Interest refers to the influence of attentional factors in the environment; whereas relevance refers to goal-directed activity (itself influenced by achievement needs and perceived utility). An *outcome* category is also added, which can be thought of in terms of attempting to apply positive reinforcement to help shape effort and accuracy. Expectancy remains intact, and refers to the learner's expectation of success. These four categories thus became the conceptual foundation on which ARCS was built.

To construct a design process, "a large list (Keller, 1987, p. 3)" of motivational strategy statements was culled from "…research findings and from practices that have resulted in motivated learners (p. 3)," and then sorted into the four categories (which were then renamed Attention, Relevance, Confidence, and Satisfaction, thus producing the ARCS acronym). Unfortunately, no indication of the validity of these "research findings and practices" is ever given, nor is a citation list provided for them, nor is a rationale provided for the sorting process. Also, while generally appearing to conform partly to expectancy-value theory, the theoretical rationale underlying the creation of *four* categories is never made clear.

As Keller began to publish "how-to" papers on ARCS implementation, the goal seems to have changed from the specific challenge of enhancing effort (as originally stated in Keller, 1979) to the diffuse task of making instruction "appealing (Keller, 1987b, p. 2)." Interestingly, Keller (1987b) also cautions against making instruction too appealing, as this will lead to overmotivation and an increase in error rates and poor efficiency. A primary task of implementing ARCS is an analysis of an expected audience's "entry level" motivation across the four ARCS categories and an adjustment of instructional materials such that motivation will be adjusted to an acceptable level as opposed to too low or too high. Again, no indication of the validity of this approach is given – Keller provides no rationale for the claim that "overmotivation" is a realistic danger, or how "appealing" instructional materials lead to more effective instruction.

One final point illustrates Keller's shift of focus away from creating effective instruction to creating appealing instruction. While designed to integrate with the typical instructional design iterative process model (specifically Dick & Carey, 1985), ARCS does not contain an evaluative mechanism to indicate its contribution to instructional effectiveness. Regarding a formative evaluation of the motivational qualities of the materials developed, Keller (1987b) recommends only a mysterious “smiley face (p. 6)” self-report measure. Even if one assumes that a smiley face indicates that some specific feature of the material is appealing, it is difficult to make the leap that the instructional effectiveness of the material has been enhanced by ARCS.

As indicated previously, to implement ARCS the instructional designer must embark on a multi-step analysis of the motivational characteristics of the learners and the existing instructional materials in order to begin selecting motivational tactics to add to the instruction. This makes ARCS a relatively laborious endeavor which few educators will undertake unless a clear enhancement of instructional outcomes could be expected to result. In addition to the theoretical vagaries mentioned above, ARCS-enhanced instructional materials have produced inconsistent results on motivation and learning outcomes (Means, Jonassen, & Dwyer, 1997).

In addition, more recent theories of motivation, particularly the goal-based theory of Locke and Latham (see Locke & Latham, 2002, and Locke & Latham, 1990, for reviews) have subsumed or replaced the earlier expectancy-value models. However, ARCS has not been revised to accommodate the newer models.

This leaves instructional designers with little guidance in the important task of enhancing learner motivation. In learning situations without a live teacher to actively attend to the motivational requirements of the environment (i.e. computer-mediated), less-than-optimal instruction will almost certainly result. Thus instructional design, particularly for computer-mediated environments, would benefit from an understanding of specific factors in the learning environment that can be manipulated to enhance learner motivation.

Goals as Regulators of Action

In their review of the history of motivation research related to schooling, Maehr and Meyer (1997) discuss the transition of motivational theory within the educational arena over the past 30 years or so from *person as decision maker* (e.g. expectancy-valence models) to *person as creator of meaning* (e.g. goal orientation theory). Covington (2000), in a similar review, notes that motivation theory has shifted from *motives as drives* to *motives as goals*. Covington further notes a practical advantage of goal theory – the goal as "practical surrogate (p.174)" for motivation.

General models of cognition over the past 40 years or so have held goals as a central motivational mechanism underlying behavior. Herbert Simon (1967), in a presentation of a general model of information processing and emotion, sees the direction of behavior as movement along a chain of goal states. In order to adapt to an ever-changing environment, an organism must have some automatic system for the evaluation of stimuli (that is to say, the potential of positive-ness or negative-ness of an encountered object) very early in information processing. The emotional response that results from this evaluation acts as an interrupt mechanism which redirects attention to real-time needs.

Simon's model has two important implications for this discussion. First, people have an innate cognitive process that quickly and automatically evaluates everything encountered in the world and labels it as positive (will help me make it to a goal) or negative (will impede my progress toward a goal). Second, and perhaps more importantly for this discussion, motivation can be thought of as an emergent property of the movement of a person from one goal state to the next. To illustrate this, consider the following oft-quoted passage from Simon (1981):

> We watch an ant make his laborious way across a wind- and wave-molded beach. He moves ahead, angles to the right to ease his climb up a steep dunelet, detours around a pebble, stops for a moment to exchange information with a compatriot. Thus he makes his weaving, halting way back home. So as not to anthropomorphize about his purposes, I sketch the path on a piece of paper. It is a sequence of irregular, angular segments – not quite a random walk, for it has an underlying sense of direction, of aiming toward a goal. (p. 63)

The ant's path appears complex, but as Simon (1981) notes, the complexity is in the environment, i.e. the surface of the beach, not the ant. We can speculate on all of the myriad physiological, emotional, and social drives within the ant, and how they might interact with various information processing functions, but ultimately it is the goal that regulates the ant's action, and brings everything else to bear on navigating the environment in order to reach it. Implicit in this notion is the idea that motivation varies in relation to the importance of a goal, and the perceived distance one is away from that goal. Distance in this context refers to all of those factors (time, hurdles and roadblocks, etc.) standing between a person and a goal.

We see this idea echoed in Soar and ACT-R. Newell (1990) specifically postulates that human cognition is, above all, goal oriented. In Soar goals act as a sort of behavioral focus point toward which the sum total of action is directed, and behavior itself is defined as movement through a problem space.

ACT-R (Anderson, et al 2004) posits a specific goal module as a critical component of the larger cognitive architecture. The goal module is responsible for the ability to abstract content and control of thought and behavior, and to keep the organism moving through a series of steps toward a final goal. In our previous example of adding n1 and n2 and writing the result in a column, if we don't already know that n1 + n2 = n3, we'll have to first go through the series of steps to determine this, which may involve adding values in the ones place, carrying over to the tens place, etc. The goal module's job is to keep track of these internal states so that our behavior serves the goal of determining the sum of n1 and n2. Through the goal module, the goal can be thought of as the marshalling force for cognition.

Further, goal operations appear to be distributed in multiple parts of the brain, as one might expect considering that this module must interact with perceptual and motor processes in addition to symbolic abstractions. As Anderson, et al (2004) note, working memory has generally been found to involve areas of the prefrontal cortex, and the dorsolateral prefrontal cortex has been implicated specifically with goal memory. In addition, Anderson, et al (2004) report on functional magnetic resonance imagery (fMRI) studies conducted on subjects performing versions of the Tower of Hanoi (see Simon, 1975, for a description) task in which the number of subgoals are manipulated. Such studies have shown the bilateral parietal regions and premotor cortex to show a response to the number of subgoals, in addition to the dorsolateral prefrontal cortex. The authors suggest that the dorsolateral prefrontal cortex maintains general cognitive control, with goal functions distributed to other brain regions, presumably when needed.

Although the language used differs, other theories considering the mechanisms of motivation are quite consistent with the above. The attribution theory developed by Weiner (1986), for example, focuses on the causal attributions a learner makes to explain success or failure. While not speaking in terms of goals per se, attribution theory rests on the assumption that motivation is determined by a performance outcome above or below a desired outcome. In the algorithmic language of Simon (1967), Newell (1990), and Anderson, et. al (2004), these desired outcomes are termed goals.

Within the instructional technology literature, this idea is further reflected in the concept of "ecological psychology" as discussed by Young (2004). While Young takes great pains to distance ecological psychology from "traditional cognitive psychology," the theoretical approach he describes is strikingly similar to that described above. He uses the metaphor of learner-as-thermostat, for example, to demonstrate the ecological psychology view that explanations of learning must arise from a consideration of the interaction of learner and environment. This is presented in contrast to the learner-as-computer metaphor, in which things are explained as "all inside the head of the learner (p. 171)." While statements such as this (and others, such as "It seems that to some extent, computers work one way and people work another," p. 170) display a shocking naiveté concerning "traditional cognitive psychology," (assuming that Simon, Newell, Anderson, and others are within the boundaries of "traditional cognitive psychology"), they highlight a focus on dynamic, continuous interaction between person and environment.

Consider Young's discussion of the Gibsonian concept of environmental *affordance.* An affordance is what the environment offers the organism, for good or for bad, and can be thought of as "possibilities for action" and "…are detected by a goal-driven agent as they move about in an information field that results from the working of their senses in concert with their body movements (p. 171)." Young further states that a stable definition of motivation must be related to the stabilities of goals, and "attentions and affordances of environments (p. 173)." The "information field" sounds strikingly similar to Newell's (1990) "problem space," while the "goal-driven agent" sounds like it comes directly from Simon (1967) and is perhaps analogous to ACT-R's goal module.

Finally, and perhaps most interestingly in regard to the current paper, Young states that from an ecological psychology perspective, inducing students to adopt new goals is an essential element of instructional design. He further clarifies that the goal adopted by the learner must be personally relevant, echoing Keller and others but seemingly unaware of the depth to which this has been explored by both goal orientation theory and Goal Setting Theory, both of which will be discussed later in this paper.

Similarities and differences to theory discussed previously notwithstanding, the important point is that Young presents another model of goal-regulated behavior, and suggests that instructional design can be made to enhance motivation by directly manipulating instructional goals. Young, however, stops short of making any actual prescriptions for enhancing motivation through instructional design – via goal manipulation or otherwise.

Locke and Latham's Goal Setting Theory (GST) (see Locke & Latham, 2002, for a review) is perhaps the most influential model of motivation to have emerged in the literature outside of educational circles. While it has not been applied to a specifically instructional context, there are volumes of quantitative studies supporting it in a similar context – using goals to improve work productivity in organizations. GST emerged from several hundred laboratory and field studies over the past 35 years (Latham & Locke, 2002). It is built on the finding that (among other things) goals directly regulate behavior, and that performance can be enhanced by manipulating goals.

Locke and Latham apply their model to very practical questions, such as "How high of a goal should I set for my workforce to maximize its performance?" Generally, it has been found that high goals lead to higher performance, and that effort toward a higher goal has more value or reward than effort toward a lower goal, even if the goal is not reached. It provides a rich literature of laboratory and field studies investigating various factors related to goals and performance, and offers specific guidance for setting goals to maximize performance. Their most reliable finding, demonstrated in hundreds of studies across a wide variety of ethnic groups and nationalities, in many different contexts, is a linear, positive relationship between goal difficulty and performance, even in situations where the goal is not reached. This effect is only attenuated by ability limits and goal commitment.

Another core finding is that specific, difficult goals lead to higher levels of performance than nonspecific goals, such as "Do Your Best" goals. Locke and Latham (1990) hold that specific goals provide an external reference point from which to evaluate one's performance, and prevent performance from being evaluated in either idiosyncratic or self-soothing ways. It is important to note that this finding directly contradicts conceptualizations of motivation, such as Keller's (1987b), that equate "motivating" instructional materials with "appealing" instructional materials. "Do your best" is almost certainly a more appealing instruction, for example, than "score 95% correct," but according to GST may very well lead to poorer performance.

Locke and Latham (1990) posit three distinct mechanisms through which goals produce their results. First, goals have an energizing function through their effect on *effort*. Second, goals impact *persistence* – defined as effort maintained over time. Finally, goals *direct* action through two components: goals *orient* the individual toward goal-relevant activity, and *activate* goal-relevant stored knowledge and skills.

As stated previously, Keller (1979) and other expectancy-value theorists perceive motivation as a multiplicative function of expectancy and value (and instrumentality, in the case of Vroom, 1964). From this perspective, and holding other factors constant, expectancy should be positively related to performance (Locke & Latham, 2002), assuming that motivation is positively related to performance. However, a difficult goal certainly would seem to produce lower expectancies that an easy or "do your best" goal, yet leads to higher performance.

As Locke and Latham (2002) discuss, this discrepancy between expectancy-value theory and their own findings can be explained by holding the effects of goal difficulty constant. Under this condition, they authors have found that expectancies are positively related to performance, i.e. the expectation that a task can be successfully performed results in a higher level of performance. However, as the authors indicate, the broader concept of self-efficacy (Bandura, 1987) provides a richer explanation of this phenomenon than expectancies. Locke and Latham (1990) have found that individuals with high self-efficacy tend to set higher goals, choose better task strategies for reaching goals, are more committed to achieving goals, and respond more positively to negative feedback. The authors view self-efficacy as an important moderator of the goal-performance relationship, with the primary effect of enhancing (or reducing) goal commitment (Locke & Latham, 2002).

For the educator, this highlights an important distinction between two possible approaches to enhancing motivation in learners. Goals are easily manipulated in an instructional situation, and offer the promise of a context-specific mechanism for enhancing performance. Manipulating or understanding the self-efficacy of students is certainly not as easy. Still, it is important for educators to understand the impact of personality factors such as self-efficacy on the goal – performance relationship. Although a philosophical or political discussion of this point is far beyond the scope of this paper, suffice it to say that a concern for such personality factors may not fall as far from the typical educator's sphere of inquiry as it does from the typical corporate manager's.

The Goal-Orientation Perspective on Academic Achievement Motivation

Dweck and Leggett (1988) provide an interesting model of *goal orientation* that may provide a useful model to educators for considering the impact of personality factors on the goal – performance relationship. Whereas GST considers the goal – performance relationship on a specific task, generally where a goal is assigned by someone else, Dweck and Leggett consider it from the perspective of the impact of personality factors on self-selected goals and performance within an educational framework. The authors propose two classes of goals: *performance goals*, where the focus is on gaining a favorable judgment of competence; and *learning goals*, where the focus is on increasing competence, regardless of the judgment of others. This tendency to select one class of goal over another has been termed the goal orientation, defined by Meece, Blumenfeld, & Hoyle (1988) as a set of behavioral intentions that determine how students approach and engage in learning activities.

The class of goal an individual selects is influenced by his or her general behavioral response pattern – either an adaptive, mastery-oriented response pattern, or a maladaptive, helpless response pattern. Whereas the mastery-oriented response pattern is associated with the seeking of challenging tasks and persistent striving even under obstacles, the helpless pattern is characterized by an avoidance of challenge and a deterioration of performance in the face of obstacles. Once the goal is selected, it then reinforces the underlying response pattern.

A rich body of research conducted over the past couple of decades (see Pintrich, 2003 for a review), has pointed out the utility of approaching achievement motivation from this perspective. This approach emphasizes the importance of how individuals think about themselves, their tasks, and their performance (Midgley, Middleton, & Kaplan, 2001), and provides a robust framework for the consideration of individual differences in academic achievement motivation.

Although different authors have developed variations on each (see March, Craven, Hinkley, & Debus, 2003, for a review), Dweck and Leggett's (1988) conceptualization of the *mastery* or *learning* goal and the *performance* or *ability* goal has remained the most robust. As discussed by Murphy and Alexander (2000), a mastery or learning goal involves a desire to develop competence and increase understanding, whereas a performance or ability goal involves a desire to gain favorable judgments, usually (but not necessarily) from others. As Elliot and Church (1997) point out, a consistent finding in the literature is that mastery or learning goals tend to be the more adaptive, and exhibit a positive relationship with *intrinsic motivation*. Intrinsic motivation is generally defined as a form of motivation characterized by engaging in activities for reasons of personal (i.e. internal) interest and enjoyment rather than external rewards. Students with a learning goal orientation are more in tune with, and influenced by, internal perceptions of content mastery than external perceptions of objective performance.

As has been found by Ames and Archer (1988), Butler (1993), and Elliott and Dweck (1988), performance goals tend to cause impairment in performance and motivation when a person does not believe he/she can meet the goal. In other words, when the goal is to validate ability, performance and motivation suffer when the goal cannot be met. Learning goals, on the other hand, focus on understanding and growth, and thus are less susceptible to negative feedback and setbacks.

Grant and Dweck (2003) break down performance goals into two further categories: performance approach goals, where the focus is on attaining success; and performance avoidance goals, where the focus is on avoiding failure. The authors note that the literature has generally found that avoidance goals predict lower intrinsic motivation and performance, while approach goals are often related positively to performance and intrinsic motivation.

It is also important to note that many researchers have found that *induced* goals – goals manipulated by the researcher - can have a causal role in achievement, and it is possible to construct learning environments in ways that enhance (and impair) performance through the use of induced goals (Grant & Dweck, 2003). This is consistent with the findings of Locke and Latham (1990), who favor the term *assigned* goals.

Thus, the literature strongly suggests that significant individual differences exist regarding the types of goals that motivate students, and that some goal types are more adaptive than others. Any application of goal-setting to enhance student motivation must take into account the individual differences represented by goal orientation.

Valuation of Effort Toward a Goal: Prospect Theory

Another important component of the role of goals in motivation is the value an individual places on effort exerted toward reaching a goal. Recall that in GST (Locke & Latham, 1990) effort, for example, is a primary goal mechanism. If instructional designers are to enhance motivation by manipulating goals, then it would be helpful to understand the process by which the value of effort is related to changes in outcome goal. Prospect Theory (Kahneman & Tversky, 1979) may provide a description of this valuation process.

Prospect Theory (Kahneman & Tversky, 1979) was originally developed to explain the seeming irrationality of human decision making in an economic context (interestingly enough, although not cited directly, this work follows the pioneering work in economic decision making of Herbert Simon, cited earlier in this paper). Among the first phenomena Prospect Theory was used to explain was framing effects. Consider the classic "Asian Disease Scenario (Tversky & Kahneman, 1981, p. 453):"

> Imagine that the US is preparing for the outbreak of an unusual Asian disease, which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume that the exact scientific estimates of the consequences of the program are as follows:
>
> If Program A is adopted, 200 people will be saved.

If Program B is adopted, there is a 1/3 probability that 600 people will be saved, and 2/3 probability that no people will be saved.

Which of the two programs would you favor?

Most participants presented this scenario were risk adverse, meaning that they chose Program A. A second group of participants was given the same scenario, but asked to choose between the following two programs:

If Program C is adopted, 400 people will die.

If Program D is adopted, there is a 1/3 probability that nobody will die, and a 2/3 probability that 600 people will die.

In this case, the majority of participants were risk seeking and choose Program D, meaning that the sure loss of 400 people was less acceptable than the 2/3 probability of the loss of 600 people. Thus, although the numerical outcomes of Programs A and C, and Programs B and D are the same, the statement of each in terms of gain or loss impacted the judgment of preference for each program.

According to Prospect Theory, outcomes are expressed as gains or losses from a neutral reference point. The psychological value of a gain or a loss is determined by an S-shaped value function (see Figure 1), which is concave above the reference point and convex below it.

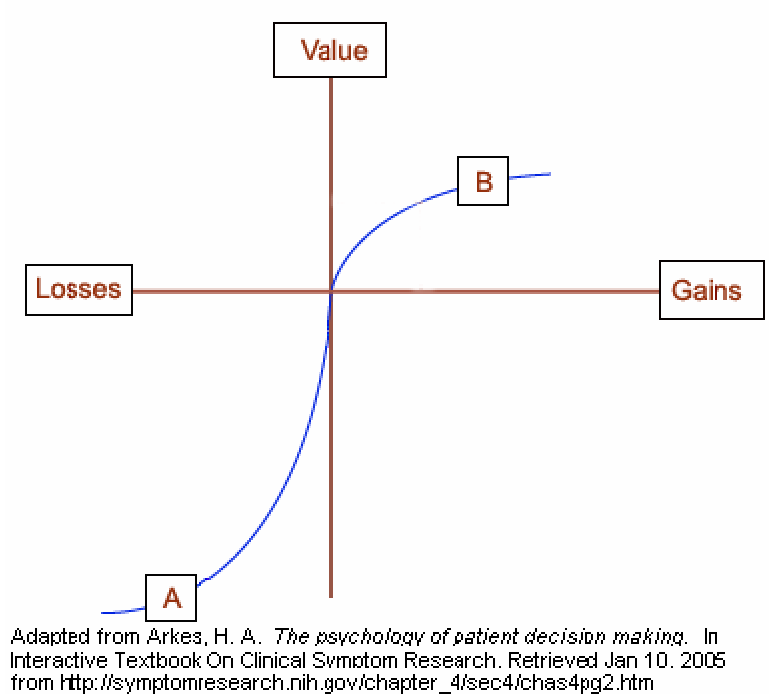

Figure 1. The Prospect Theory value function.

Thus, the response to loss is more extreme than the response to a gain of equal quantity, such that "losses loom larger than gains (Kahneman & Tversky, 1979)." In other words, the pain associated with a loss of 400 people is greater than the pleasure associated with saving 200 people. This leads to the finding of "loss aversion," and risk seeking in the domain of losses. In addition, the shape of the value function produces diminishing sensitivity in the psychological value of the difference between a gain (or loss). For example, someone who might happily drive an extra five miles to save $10 on a $20 calculator wouldn't be willing to cross the street to save $10 on a $30,000 car.

Heath, Larrick, and Wu (1999) report results that suggest the ability of a performance goal to act as a reference point in Prospect Theory's value function. Rather than present participants with scenarios involving the gain or loss of lives (as in the Asian

Disease scenario mentioned above) or money, and finding a preference reversal when equivalent outcomes are framed as a loss or gain, Heath, et al. (1999) presented participants with performance scenarios and found a framing effect when equivalent performance outcomes were above or below a performance goal. Consider the following example (Heath, et al. p. 84):

> *Sally and Trish both follow workout plans that usually involve doing 25 sit-ups. One day, Sally sets a goal or performing 31 sit-ups. She finds herself very tired after performing 35 sit-ups and stops.*
>
> *Trish sets a goal of performing 39 sit-ups. She finds herself very tired after performing 35 sit-ups and stops.*

Heath, et al. (1999) found that 100% of participants listed a positive emotion for Sally and a negative one for Trish. Further, when asked who was experiencing more emotion, a significant majority of participants chose Trish. The authors explain these results in terms of Prospect Theory, and conclude that the goal acts as a reference point to divide outcomes into regions of gain and loss. Further, Prospect Theory's value function comes into play, and leads participants to value the outcome of four sit-ups below the goal of 35 as more psychologically unpleasant than the outcome of four sit-ups above the goal is pleasurable.

Heath and colleagues report on an additional 10 scenarios, each of which provide support for the use of Prospect Theory as a cognitive explanation of goal-related performance, specifically translated into basic motivational processes like affect, effort, persistence, and performance.

Thus, like money or lives saved, there are three basic principles or predictions that Prospect Theory makes regarding goals:

1. The goal establishes a reference point dividing potential outcomes into regions of gain or loss;
2. The S-shaped value function, with the goal-as-reference-point in the center, is used to evaluate outcomes. The upshot of this is that outcomes perceived as losses, which is to say goals that are not met, are more painful than gains of the same size are pleasurable.
3. As one moves farther from the goal-as-reference point, the magnitude of perceived change diminishes. For example, someone will work harder to perform the 9th sit-up if his or her goal is 10 sit-ups as opposed to 20. This is the property of diminishing sensitivity.

Diminishing sensitivity in the goal context potentially allows the instructional designer to make some specific predictions regarding effort near a goal. As noted by Heath, et al. (1999), diminishing sensitivity gives the value function its S-shape: concave above the reference point and convex below it. Thus, the value of effort becomes greater as one approaches a goal. For example, suppose that Joe is enrolled in a class in which the grade is based on a point total from 15 weekly 10-point quizzes, and he has set a goal of making an A in the class (which requires a total of 135 points). Assume that it is week three, and Joe's performance has been consistently good on the previous two quizzes (9 points each). As shown in Figure 2, if we look at Joe's current position on the value function, we see that the slope of the function corresponding to the 10 possible points of Quiz 3 is not as steep as the slope of function corresponding to the 10 possible points of Quiz 9. Hence, the effort required to earn 10 points on Quiz 3 will be valued less than the effort required to earn 10 points on Quiz 9 because the rate of benefit of effort exerted toward Quiz 9 is greater. In other words, because of the slope of the value function under Quiz 3 and Quiz 9, there will be more units of value corresponding to Quiz 9.

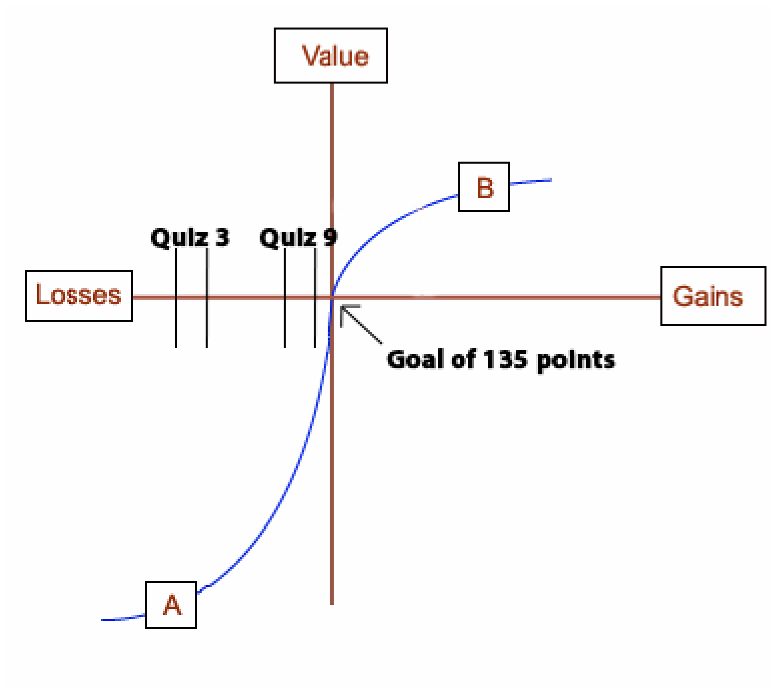

Figure 2. Differences in value function slope.

Investigating Goal Messaging in an Instructional Context

An initial study (Bunch & Kealy, 2005) produced some promising results for the potential use of goals to enhance motivation in an instructional context and provides tentative support for Prospect Theory as an underlying cognitive valuation function for outcomes relative to goals in an instructional context. This study had participants complete the learning goal subscale of the Achievement Goal Inventory (AGI) (Grant & Dweck, 2003), in addition to some hypothetical framing scenarios, similar to those given by

Tversky and Kahneman (1981) and Heath, et al. (1999), but re-written to occur within an educational context. Framing effects consistent with those found in the contexts in which the scenarios were originally written were found, and were robust across degree of learning goal orientation.

One of the scenarios was an original one involving *grade framing*. In this scenario, participants were asked to imagine themselves at the end of the term, just prior to the final exam, in a class "important for your major and your career." An explanation of the grading system used by the instructor is then given, with the only difference between versions being that in one version ("below-goal") a goal score on the final exam is stated in terms of gaining enough points to move from a lower grade to a higher one, whereas in the other version ("above-goal") the goal score on the final exam is stated in terms of not losing enough points to move from a higher grade to a lower one. In both conditions the performance required to obtain an A in the class was exactly the same.

Participants in the below-goal group were found to have a higher emotional reaction and gave larger estimates of the amount of time they would spend studying for the final exam than those in the above-goal group, although this effect was stronger for participants with a high learning goal orientation. Participants were not given the AGI's performance goal items, so it is possible that those scoring high on the learning subscale were simply more concerned with learning and performance than those with low scores.

Bunch and Kealy (2005) was a preliminary investigation of the effects of *goal messaging*, defined here as the statement of a specific performance goal or goals the learner should attempt to achieve. This is a facet of the learning environment that instructional designers can manipulate relatively easily, and Prospect Theory makes two specific predictions about it. First, negatively-framed goal messages (where the learner begins below the goal, and has to gain points, for example) should be more motivating than positively-framed goal messages (where the learner begins above the goal, and has to avoid losing points, for example). Second, goal messages that keep the learner in the steepest part of the value function the longest (in other words, where the goal is close but not yet reached) should be more motivating than goal messages that are either easy to obtain or too difficult to obtain.

The current study tests these predictions in a Web-based learning task. Students were assigned to one of three goal difficulty groups: an "easy" group, where the goal would be to obtain a score generally reached by the majority of students; a "challenging" group, where the goal would be to obtain a score reached by only the very highest-scoring students; and a "highly improbable" group, where the goal would be to obtain a score higher than that reached by the very highest scoring students. According to Prospect Theory, the "challenging" goal message should produce the highest motivation of the three groups. Participants should spend more time in the steep part of the curve as they approach the goal without reaching it (or only reach it toward the end of the tutorial). The easy goal would be met early on, and thus the value of effort toward the goal would rapidly decrease as performance surpassed and moved away from it. As in the pilot study, the "highly improbable" goal would begin to appear as distant, and thus effort toward it would never benefit from reaching the steepest part of the curve.

In addition, according to Prospect Theory goal message framing should impact motivation and thus performance. In the current study, half of the students were told that they start the tutorial with 100 points and would lose 1 point for every question answered incorrectly, thus placing them above the goal at the beginning of the tutorial. The other half were told that they start the tutorial with no points, and would gain 1 point for each question answered correctly, placing them below the goal at the start of the tutorial. In this case, the steeper slope of the value function below the goal should be felt more intensely than the corresponding point on the value function above the goal, thus motivation and performance should be enhanced for the below-goal group.

A student's goal orientation should also come into play here. Clearly, goal messages such as these fall squarely within the performance goal category. Students with a strong learning or mastery goal orientation may be less susceptible to the influence of such goal messages in general, especially if these students perceive themselves to have gained an adequate amount of knowledge from the experience. For these students, an internal perception of content mastery, as indicated by the perception of amount learned for the effort, will be of much greater concern than an objective measure of performance.

Students with a high performance goal orientation, on the other hand, should be most susceptible to this sort of goal message. For students with a learning or mastery goal orientation, intrinsic motivation should be higher if the amount learned is judged to be higher, and should be less influenced by performance. For students with a strong performance goal orientation, intrinsic motivation should suffer when performance suffers, and when effort toward the goal is judged to be of less value.

Chapter Three: Research Methods

Participants

Participants were 141 female and 79 male undergraduate students enrolled in introductory computer and introductory educational technology classes at a large public university and a large community college (mean age=21). The tutorial content is part of the regular curriculum of the course. Participants completed the tutorial during a regularly scheduled class meeting.

A power analysis, with 80% power ($1-\beta = .8$), an alpha of .05, and a "medium" effect size of $f = .25$, indicated that a total of 162 participants would be needed. This analysis is based on detecting the interaction effects of a 2 x 3 independent groups design with no covariates. Power will therefore be slightly higher for each main effect, and higher still if covariates are found to explain some of the variance in the dependent variables.

Design

Participants were randomly assigned to one of six treatment groups representing Message Frame (above goal vs. below goal) and Goal Difficulty (easy vs. challenging vs. highly improbable) between subjects factors. These factors were crossed with 10 Tutorial Sections as a repeated measure, producing a 2 Message Frame X 3 Goal Difficulty X 10 Tutorial Section design. The treatment conditions are defined as follows:

Message Frame. Participants in the above goal group were shown an initial performance score of 100 points, and told that for each question missed they would lose 1 point. All feedback messages were displayed from this perspective, i.e. "You currently have 94 points. You lost 1 point on this question." Participants in the below-goal group were shown an initial performance score of zero points, and told that for each question they would gain 1 point, i.e. "You currently have 5 points. You gained 1 point on this question."

Goal Difficulty. Goal Difficulty groups were created as follows: an "easy" group, where the goal was to score at least 20% correct (achieved by 90% of participants in a pilot study, see Appendix B); a "challenging" group, where the goal was to score at least 79% correct (achieved by 10% of participants in a pilot study), and a "highly improbable" group, where the goal was to score 92% correct (reached by no participants in a pilot study). As the theoretical predictions regarding the Goal Difficulty variable come from Goal Setting Theory (Locke & Latham, 1990), two recent studies assessing the effect of Goal Difficulty within the context of Goal Setting Theory by Locke, Latham, and colleagues provided guidance for the criterion values used in the current study. In a study of individual performance in a simulated industrial management task, Latham and Seijts (1999) state that a difficult goal is one that only 10% of participants can reach, and to establish their difficult goal group the authors use the performance score obtained by the upper 10% of participants in a pilot study. In a study of small team performance in a computer task, Knight, Durham, and Locke (2001) also base their difficult goal condition on the performance of the upper 10% of scores in a pilot study, and their easy goal condition on the performance of the upper 90% of score in a pilot study.

In an effort to maximize the validity of the Goal Difficulty condition, group criteria is based on observed results with the same stimulus in the same context, i.e. the pilot study tutorial and results. In order to be as frame-neutral as possible, Goal Difficulty will be stated in terms of final points needed to meet the goal, i.e. "Your goal is to have 40 points at the end of the tutorial."

Dependent measures. Section quiz scores served as the main dependent measure for the study. After these performance tasks were completed, participants completed items designed to assess a) intrinsic motivation, b) tutorial difficulty, and c) perceived amount learned. Following the completion of the experimental sessions, the data were analyzed in a 2 Message Frame x 3 Goal Difficulty between-participants factorial design, with AGI subscale scores serving as regressors.

Materials

The experimental tutorial used in the current study was developed in an iterative process over three stages (see Appendix B). The content of the tutorial is presented in Appendix C.

Participants completed the outcome goal, ability goal, learning goal, and normative goal subscale items of the Achievement Goal Inventory (AGI) developed by Grant and Dweck (2003) (see Appendix A). These four subscales consist of 18 statements related to goal orientation to which the participant indicates agreement on a seven-point Likert-type scale, ranging from *strongly disagree* to *strongly agree*. The outcome, ability, and normative goal subscales each measure a facet of performance goal orientation. In Grant and Dweck (2003) study 1, the AGI was administered to 451 participants and found to demonstrate reasonable internal consistency, with subscale alphas ranging from .81 to .92. A confirmatory factor analysis of this data produced a hierarchical model with four primary factors consisting of the learning goal, outcome goal, ability goal, and normative performance goal items.

In addition, participants were asked to rate their agreement on a four-point Likert-type scale with each of seven statements. The first four were intrinsic motivation items (from Elliot & Church, 1997; Grant & Dweck, 2003): a) “I thought the tutorial was very interesting,” b) “the tutorial was a waste of time,” c) “the tutorial was boring,” and d) “I enjoyed the tutorial very much.” Following the intrinsic motivation items were two difficulty items: a) “the tutorial was difficult,” and b) “the tutorial was challenging.” Last was the statement “I learned a lot from the tutorial.”

Each participant’s age, gender, years in college, and major were also collected.

Procedure

All materials were administered during a single, regularly-scheduled class meeting. Students were briefed on the nature and purpose of the tutorial and study, and given brief instructions on how to proceed. These instructions included the explicit statement, repeated at least twice verbally, that all responses are completely anonymous, that the only information given to the course instructor would be a list of students who completed the entire tutorial, and that extra credit is only contingent upon completing the tutorial and not on score.

Following these verbal instructions, students were instructed to open a Web browser and enter the URL of the tutorial in its address bar. The first page of the tutorial Web site checks to ensure that the browser settings will allow for the proper functioning of the tutorial, and that the tutorial browser window is sized correctly. Once this was done, the participant clicked a “Continue” button and continued to a page of written instructions that re-stated the verbal instructions given previously and informed the participant of the nature of the task. After reading these instructions, the participant clicked another

"Continue" button. At this point the Web application randomly assigned the participant to one of the six treatment groups. Next, the demographic data was collected, and the participant was asked to rate on a four-point scale (where one indicates *strongly agree*, and 4 *strongly disagree*) his or her agreement with the following three statements related to the relevancy of the tutorial content: *1. This class is relevant to my career goals; 2. Information about the history of the Internet is relevant to my career goals;* and *3. I have a personal interest in knowing more about the history of the Internet.*

Following this the AGI was administered. Following the AGI, the participant was presented with a goal message and framing page, on which goal message statements appropriate to the participant's treatment group were displayed. Students in the below-goal frame, and "challenging" difficulty group, for example, were presented with the screen appearing as Figure 3.

The participant then clicked a "Proceed to the next step >>>" button and continued to the start of the first tutorial section. Each tutorial section began with a two-page text passage, followed by 10 multiple choice questions based on the text passage. Each question was displayed on a page by itself, and was presented in a random order. Students could navigate back and forth between the two text pages, but can not return to the text once the quiz was started. Also, once a response is submitted the student could not return to the question, and each question required a response before the next question could be accessed.

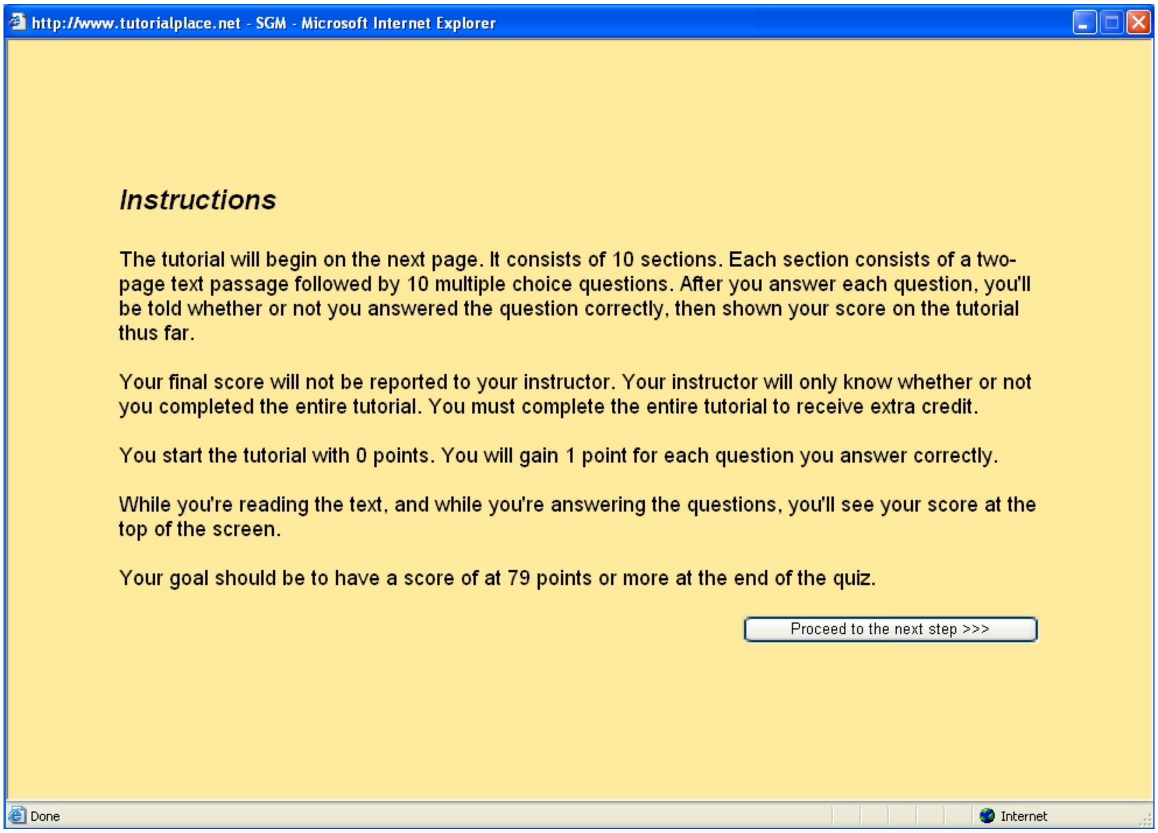

Figure 3. Statement of goal message for challenging score group starting below the goal.

On each page of the text passage, the overall score was displayed in the upper right corner of the browser window on the two text pages of each section. In the upper left corner, the Goal Difficulty message was displayed. For a participant in the above-goal frame, and "highly improbable" difficulty group, the messages displayed in the upper right and left can be seen in Figure 4.

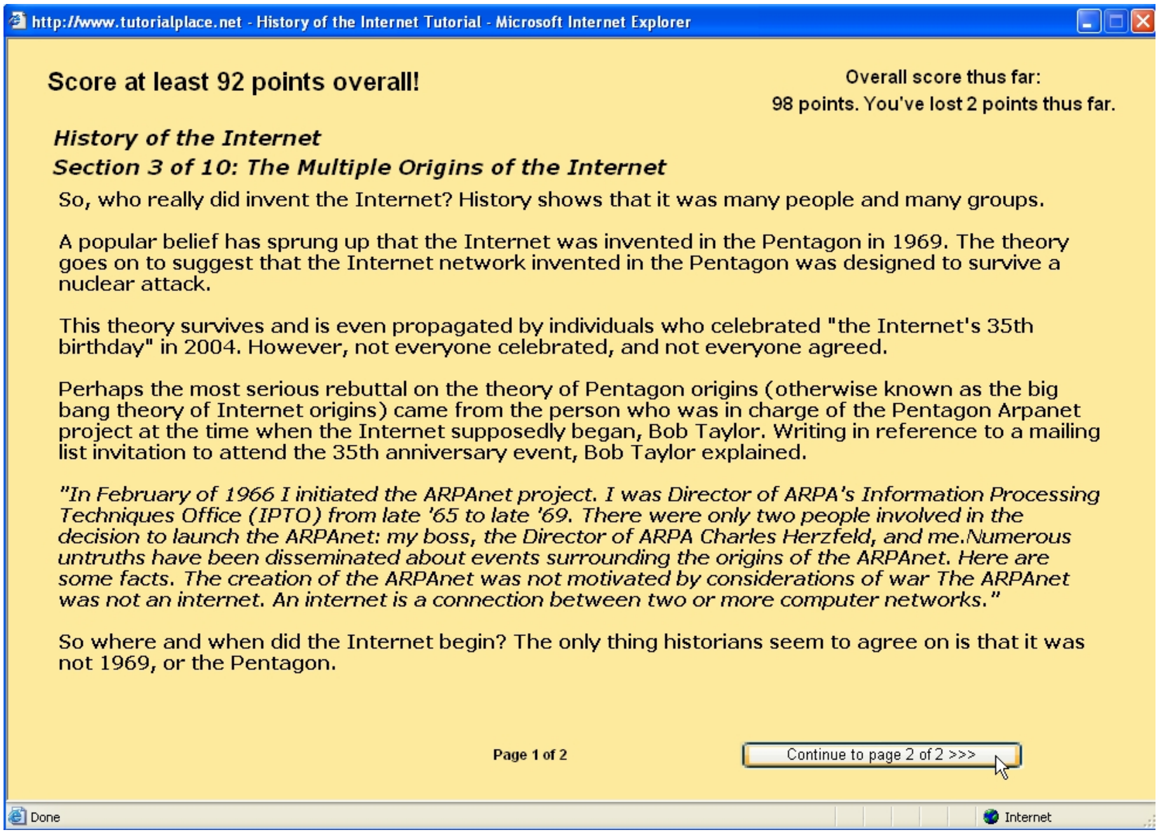

Figure 4. Sample tutorial text passage, page 1.

Following the two text pages at the beginning of each section, the participant was presented with each multiple choice question. As in the two text pages at the beginning of each section, the Goal Difficulty message was presented in the upper left corner of the browser window. Both the overall score and the section score thus far were displayed in the upper right corner, in a manner consistent with the goal frame group (see Figure 5).

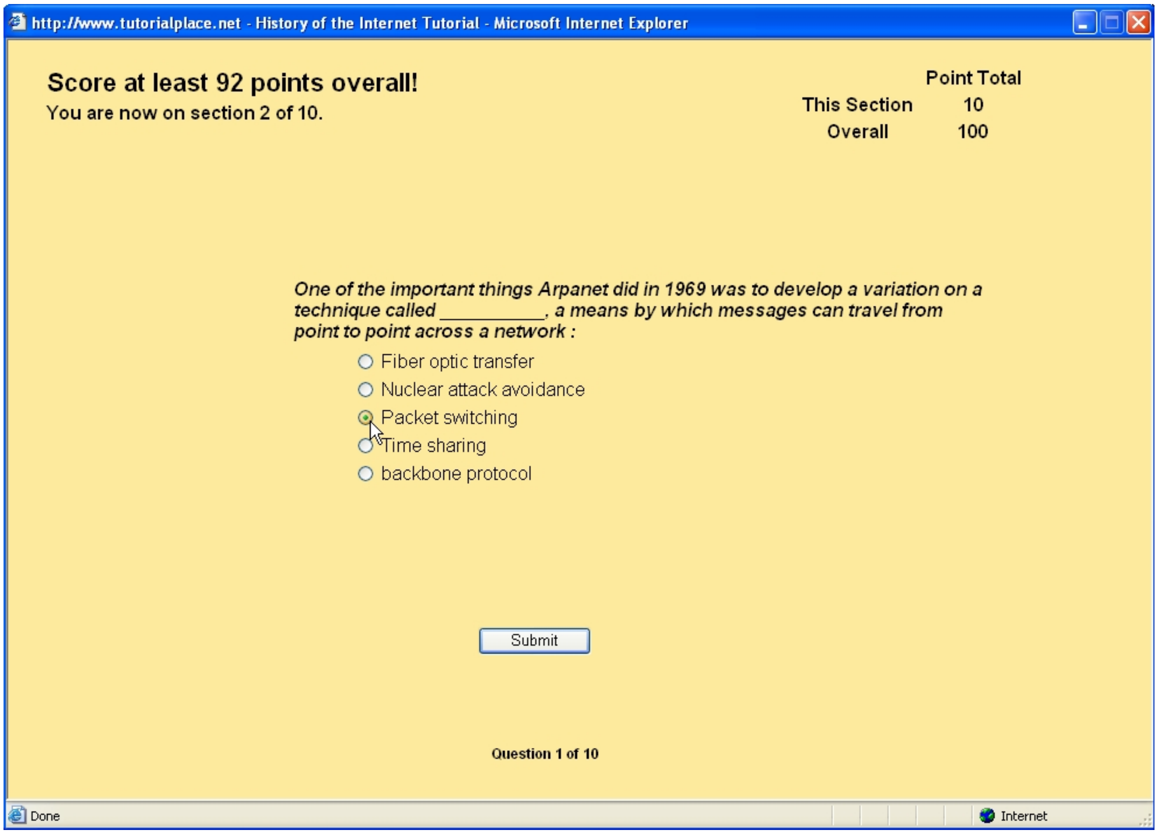

Figure 5. Sample multiple choice quiz item.

Figure 6 provides a screenshot of feedback following a correct response to a quiz item. Figure 7 provides a screenshot of feedback following an incorrect response.

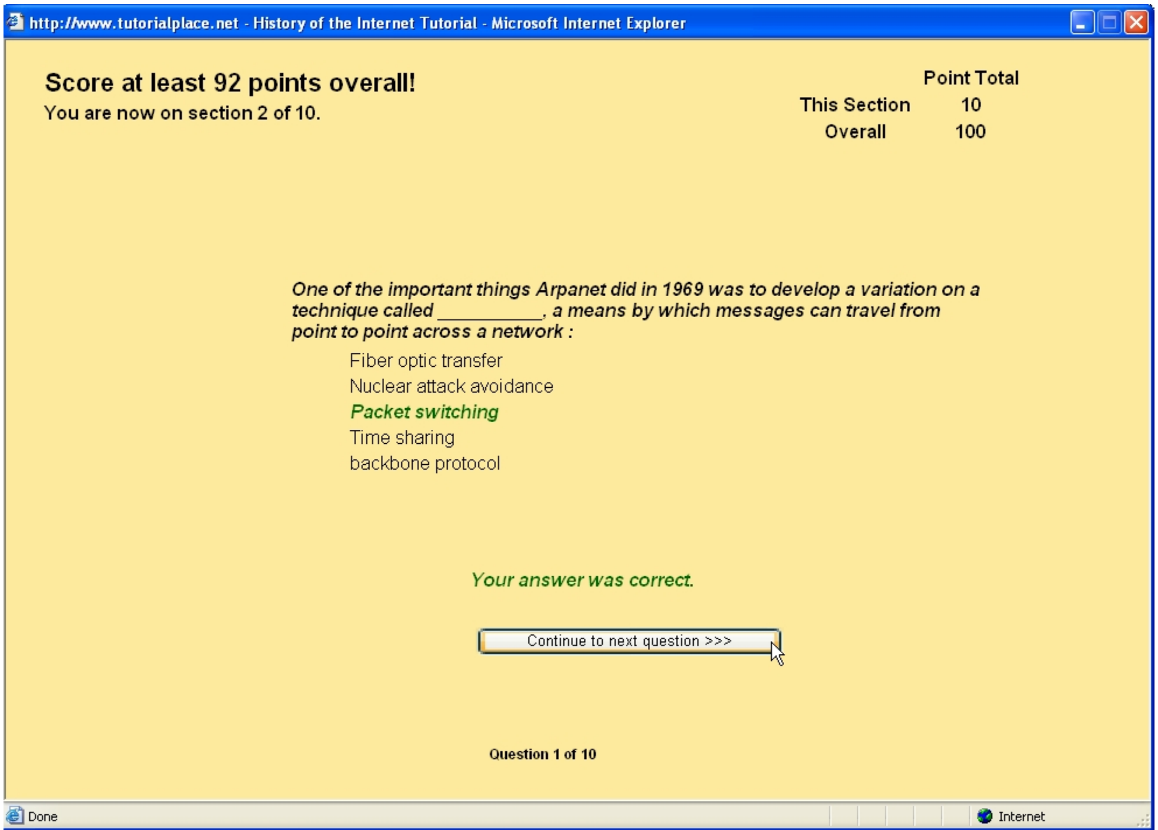

Figure 6. Feedback following a correct quiz item response.

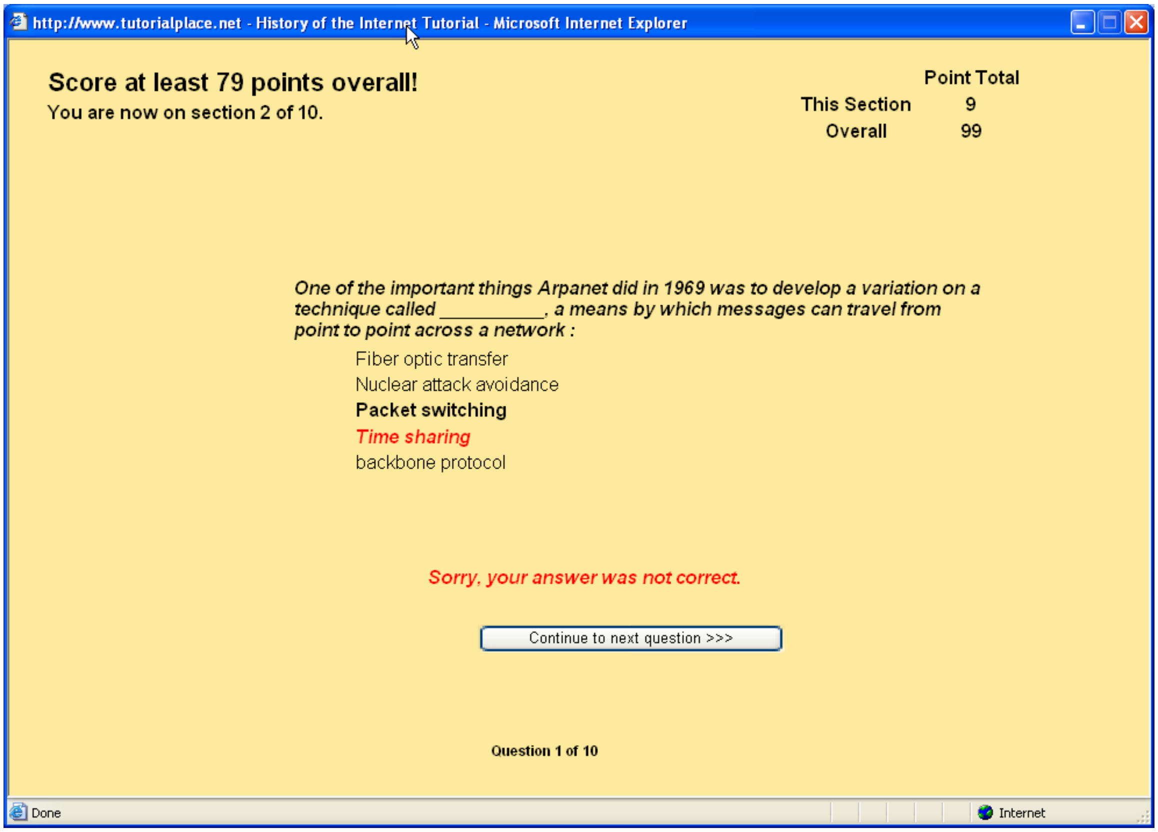

Figure 7. Feedback following an incorrect quiz item response.

Following the last multiple choice question in each section, a section summary was presented (see Figure 8).

Both the section and overall performance were displayed, in a manner consistent with the goal framing group. The Goal Difficulty message was also displayed. Following the section summary, the next tutorial section begins.

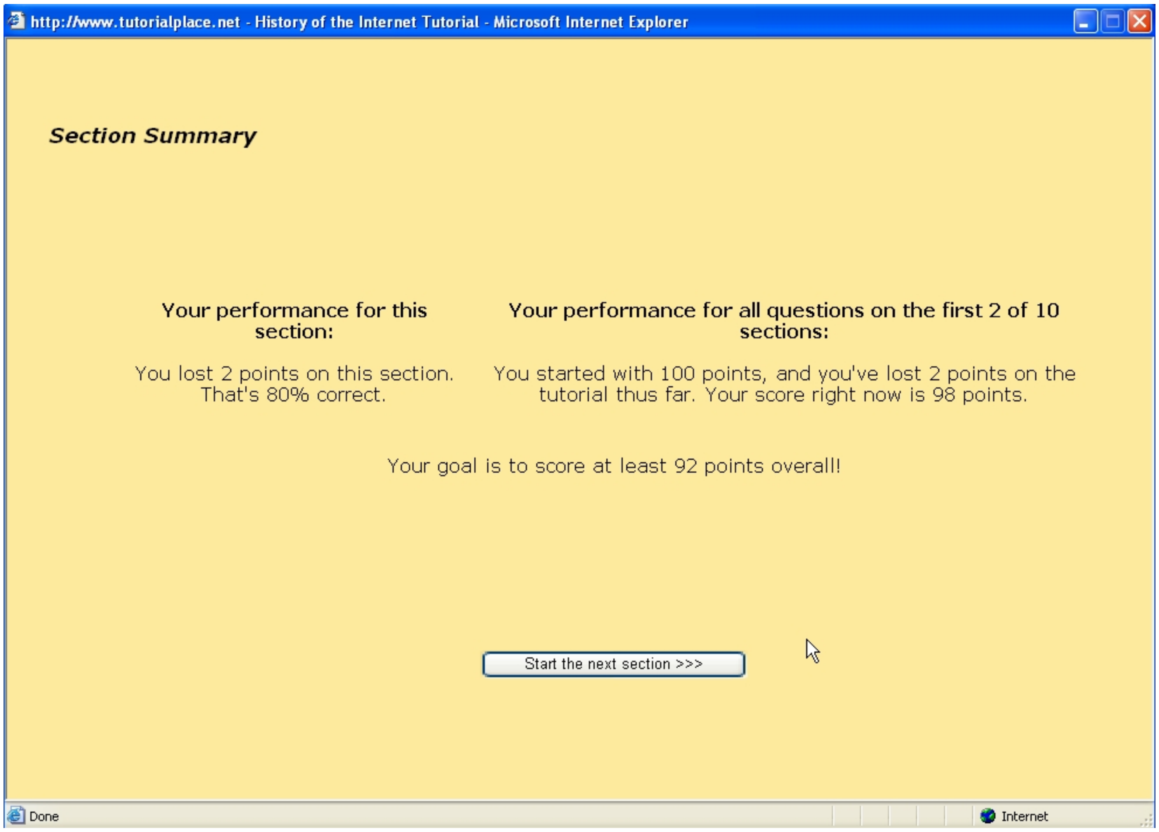

Figure 8. Section summary following section quiz.

Once the section summary of the tenth and final tutorial section was displayed, participants were prompted for the intrinsic motivation, tutorial difficulty, and perceived learning item ratings. After the student completed the final item, they were thanked for their participation and dismissed from class. Based on the results of the preliminary studies discussed in Appendix B, it was expected that all participants would complete the materials within the scheduled class meeting time.

Chapter 4: Results

Of the 220 students who began the tutorial, 34 did not complete it. No differences were found between the number of participants in each treatment group abandoning the tutorial, X^2 (5, N = 220) = 1.05. Table 1 lists participant counts for each treatment group, along with participant attrition.

Table 1

Treatment group sizes, and participant attrition. Tabled values are n.

Goal Difficulty	Frame	Completing Tutorial	Not Completing Tutorial	*Total*
Easy	Above	34	6	40
	Below	29	6	35
Challenging	Above	30	6	36
	Below	29	6	35
Highly Improbable	Above	30	6	36
	Below	34	4	38
	Total	186	34	220

A two-way ANOVA using Goal Difficulty and Message Frame as independent variables and number of sections completed as the dependent variable produced no significant main effects or interactions (all F's < 1).

A series of one-way ANOVAs using completing the tutorial vs. not-completing the tutorial as the independent variable, and each of the AGI scale scores as dependent variables, indicated no relationship between AGI subscale scores and completing vs. not completing the tutorial. No significant main effect of completing vs. not completing the tutorial was found on the Learning, Normative, Outcome, or Ability scale scores of the AGI (all *F*'s < 1).

In addition, no significant correlation was found between the number of sections completed and AGI subscale scores. Data for students not completing the entire tutorial were left out of further analysis.

Descriptive statistics for the AGI scales appear in Table 2. Analysis of frequency distributions of AGI scales indicated eight outliers scoring more than three standard deviations away from the mean on at least one of the AGI scales. The data for these eight participants were left out of further analysis.

Table 2

Descriptive statistics for the four Achievement Goal Inventory scales.

	Outcome	Ability	Normative	Learning
Mean	18.99	15.95	27.38	32.00
Median	20	17	28	33
SD	3.23	4.17	8.73	7.10

Of the remaining 178 students, Alpha for items on the AGI Outcome scale (for participants completing the tutorial) was found to be .9, .83 for the Ability scale, .9 for the Normative scale, and .89 for the Learning scale, indicating reasonable internal consistency for these scales, and replicating findings by Grant & Dweck (2003).

The distribution of overall performance is presented in Figure 9. The mean number of items correct out of 100 was 49.5, with a median of 46.5, a mode of 36 (SD = 17.58). Ten percent of participants scored below 27.9, while 90 percent scored below 78.1. The range was from 17 to 94.

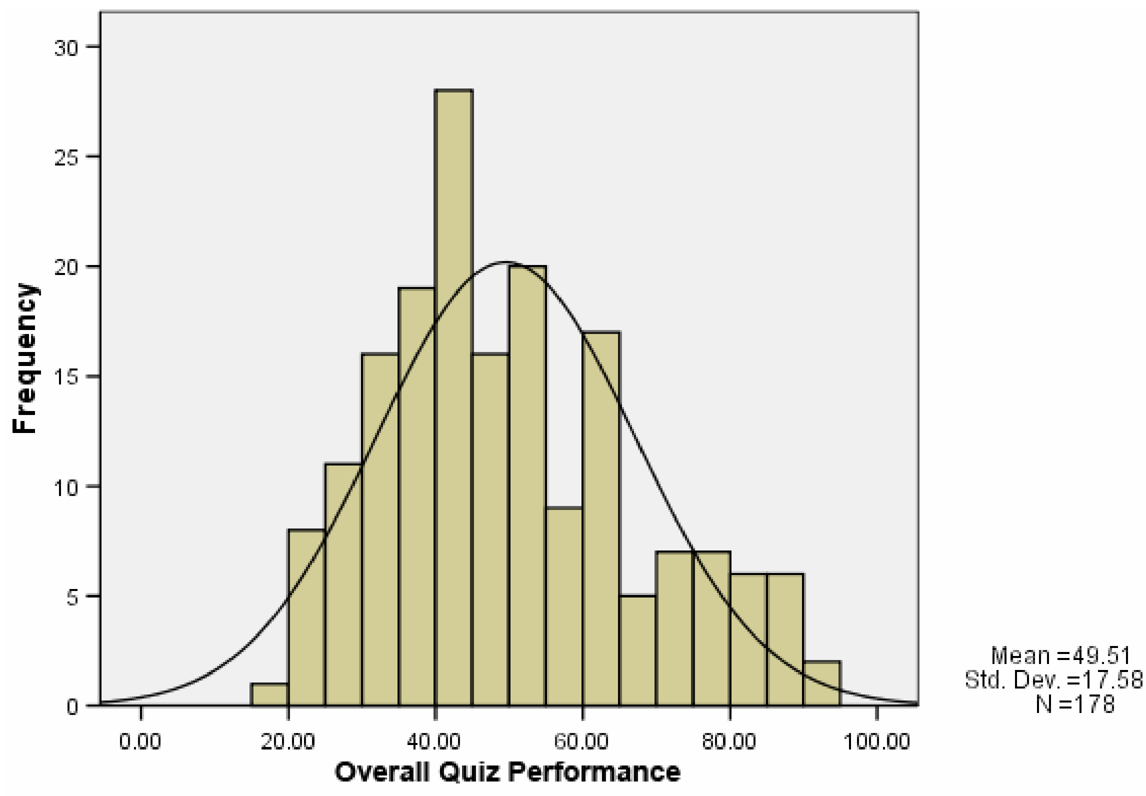

Figure 9. Frequency distribution of sum of section quiz scores (number correct out of 100 total items).

Table 3 displays KR-20 values for items on each of the 10 section quizzes for participants completing the entire tutorial. KR-20 values ranged from .59 to .81, indicating adequate internal consistency.

Table 3

KR-20 values for section quiz items (for participants completing the tutorial)

Section	1	2	3	4	5	6	7	8	9	10
KR-20	.60	.66	.64	.63	.78	.81	.62	.73	.72	.59

Alpha for the four intrinsic motivation items was .65. Mean for the intrinsic motivation items was 11.17 (SD = 2.37), with a median of 11, and ranged from 5 to 16. Items were scored such that a rating of 1 indicated a response of *strongly agree*, and a rating of 4 indicated a response of *strongly disagree*. The items *The tutorial was a waste of time* and *The tutorial was boring* were reverse-scored, then the ratings of the four items were summed to produce the intrinsic motivation score. Thus, potential scores ranged from a low of 4 (indicating the highest level of intrinsic motivation) to 16 (indicating the lowest level of intrinsic motivation).

Alpha for the two items indicating tutorial difficulty, *The tutorial was difficult* and *The tutorial was challenging* was .88. Ratings of the two items were summed for each participant to produce a tutorial difficulty score. Mean tutorial difficulty score was 4.98 (SD=1.62), with a median of 5. Difficulty ratings ranged from 2 to 8. Items were scored such that a rating of 1 indicated a response of *strongly agree*, and a rating of 4 indicated a response of *strongly disagree*. Thus, a tutorial difficulty score of 2 indicates the highest possible rating of tutorial difficulty, and a score of 8 indicates the lowest possible rating of tutorial difficulty.

Figure 13 displays the mean section quiz scores for each group across the 10 tutorial sections.

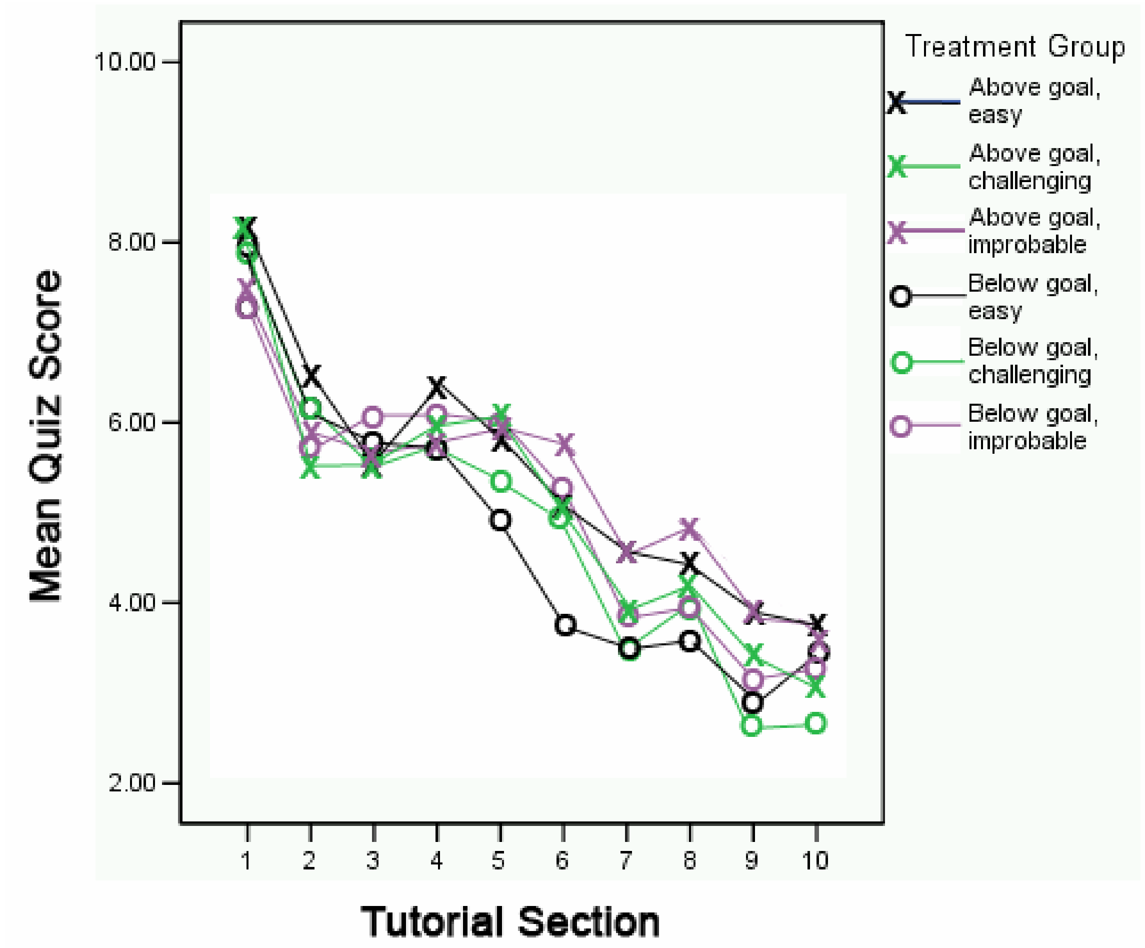

Figure 13. Mean section quiz scores by treatment group.

Group differences in section quiz scores were analyzed in a general linear model analysis of covariance (GLM ANCOVA), with Tutorial Section as a repeated measure and scores on each of the AGI scales as covariates. Mauchly's test of sphericity on the within subjects effect of Tutorial Section was significant, thus a Huynh-Feldt epsilon value of .982 was used to adjust the degrees of freedom for all F-tests in the ANCOVA. Results are presented in Table 4.

Table 4

GLM Analysis of Covariance for tutorial quiz scores

Source	*df*	*F*	η_p^2	*p*
		Between subjects		
Message Frame (F)	1	3.18	.021	.077
Goal Difficulty (D)	2	2.06	.027	.131
AGI Normative (N)	1	.863	.006	.355
AGI Learning (L)	1	.004	.000	.948
AGI Outcome (O)	1	2.99	.020	.086
AGI Ability (A)	1	4.87*	.032	.029
F X N	1	2.90	.019	.091
F X L	1	.52	.004	.471
F X O	1	.70	.009	.499
F X A	1	.39	.003	.536
D X N	2	.01	.000	.990
D X L	2	1.78	.024	.172
D X O	2	1.91	.025	.151
D X A	2	2.73*	.036	.029
F X D	2	.15	.002	.858
F X D X N	2	.09	.001	.916
F X D X L	2	.22	.003	.801
F X D X O	2	.70	.009	.499
F X D X A	2	.87	.012	.420
error	148	(29.69)		
		Within subjects		
Tutorial section (S)	8.842	1.84	.012	.058
S X O	8.842	.89	.006	.529
S X A	8.842	1.94*	.013	.044
S X N	8.842	.72	.005	.686

Table 4 (Continued)

Source	df	F	η_p^2	p
S X L	8.842	.99	.007	.443
S X F	8.842	.39	.003	.937
S X D	17.684	.98	.013	.484
S X F X O	8.842	.84	.006	.581
S X F X A	8.842	1.93*	.013	.046
S X F X N	8.842	1.44	.010	.169
S X F X L	8.842	.76	.005	.626
S X D X O	17.684	.78	.010	.720
S X D X A	17.684	1.84*	.024	.018
S X D X N	17.684	.84	.011	.651
S X D X L	17.684	1.84*	.024	.018
S X F X D	17.684	.98	.013	.484
S X F X D X O	17.684	1.08	.014	.364
S X F X D X A	17.684	1.30	.017	.179
S X F X D X N	17.684	.42	.006	.984
S X F X D X L	17.684	.417	.013	.505
error (S)	1308.649	(3.128)		

Notes. Values in parenthesis represent mean square errors. p values are based on the Huynh-Feldt adjustment.

* $p < .05$. ** $p < .01$.

A main effect was found for AGI Ability scale score, $F\,(1,148) = 4.87$, p=.029, η_p^2=.032. Generally, as participants scoring higher on the AGI Ability scale achieved lower section quiz scores. While the main effect was significant, strength of association as measured by η_p^2 indicates a weak relationship. The regression of AGI Ability score on mean section quiz score is depicted in Figure 14.

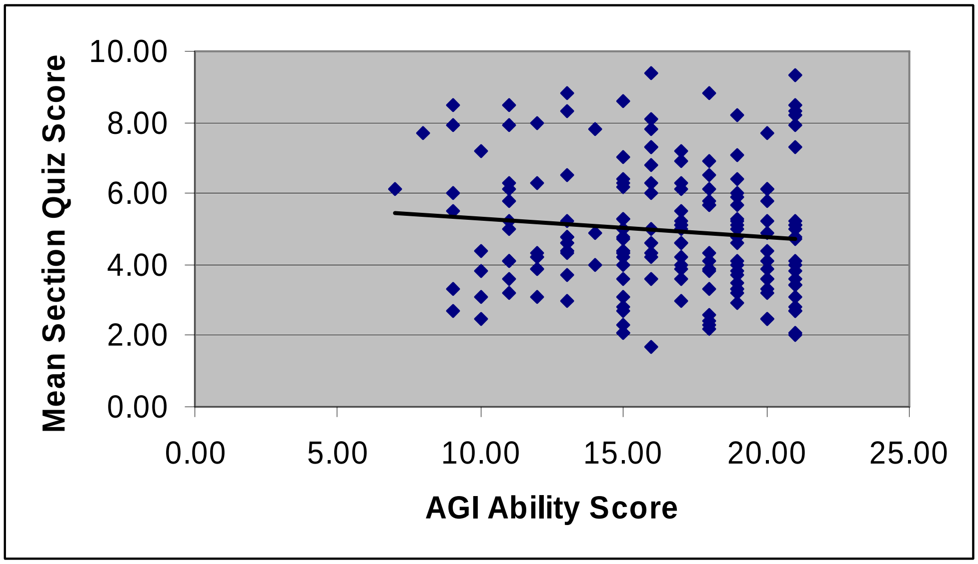

Figure 14. Regression of AGI Ability score on mean section quiz score.

While no main effects were found for the treatment variables, a significant interaction was found between Goal Difficulty and AGI Ability scale score, F (2, 148)=2.73, p=..029, η_p^2=.036. Although the strength of association is weak, as can be seen in Figure 15, participants in the challenging and improbable Goal Difficulty groups with higher AGI Ability scores tended to achieve a lower mean section quiz score. For participants in the easy Goal Difficulty group there was no apparent relationship between AGI Ability scores and mean section quiz scores.

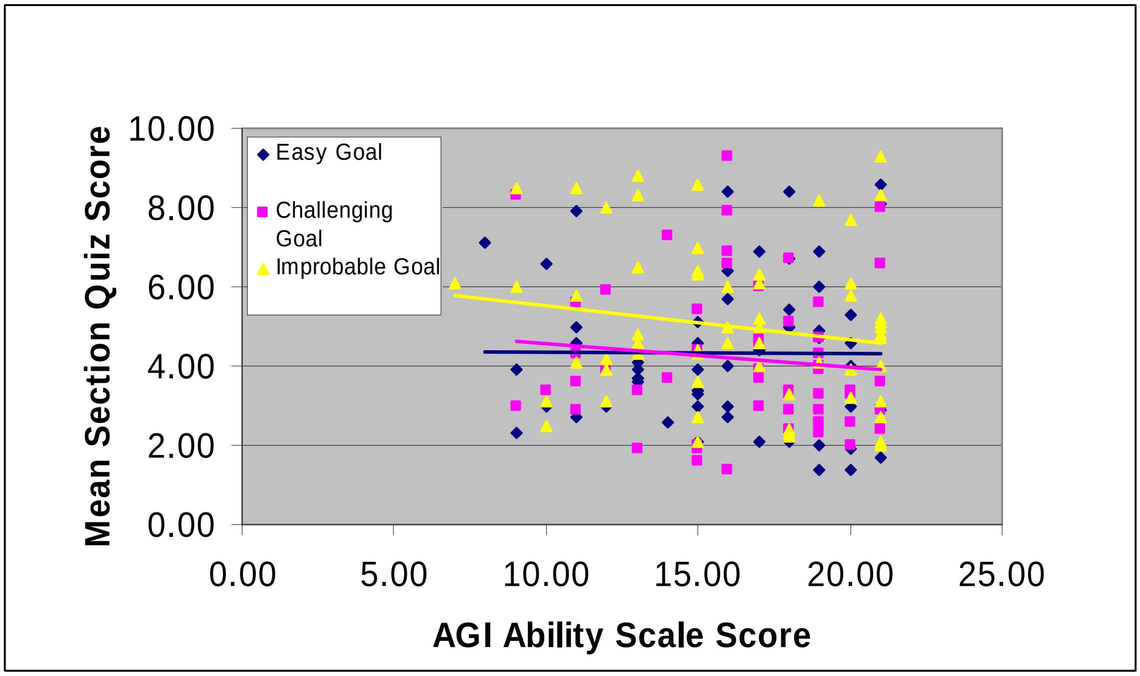

Figure 15. Regression of AGI Ability score on mean Tutorial Section quiz scores for each Goal Difficulty group.

A significant yet small interaction was found between Tutorial Section and AGI Ability scale score, F (8.842, 1308.649) =1.94, p=.044, η_p^2=.013. While participants scoring lower on the AGI Ability scale tended to perform better on section quiz scores overall, this effect was not consistent across Tutorial Sections. Figure 16 displays the regression of AGI Ability score on each of 10 section quiz scores. While the interaction was significant, strength of association was again weak.

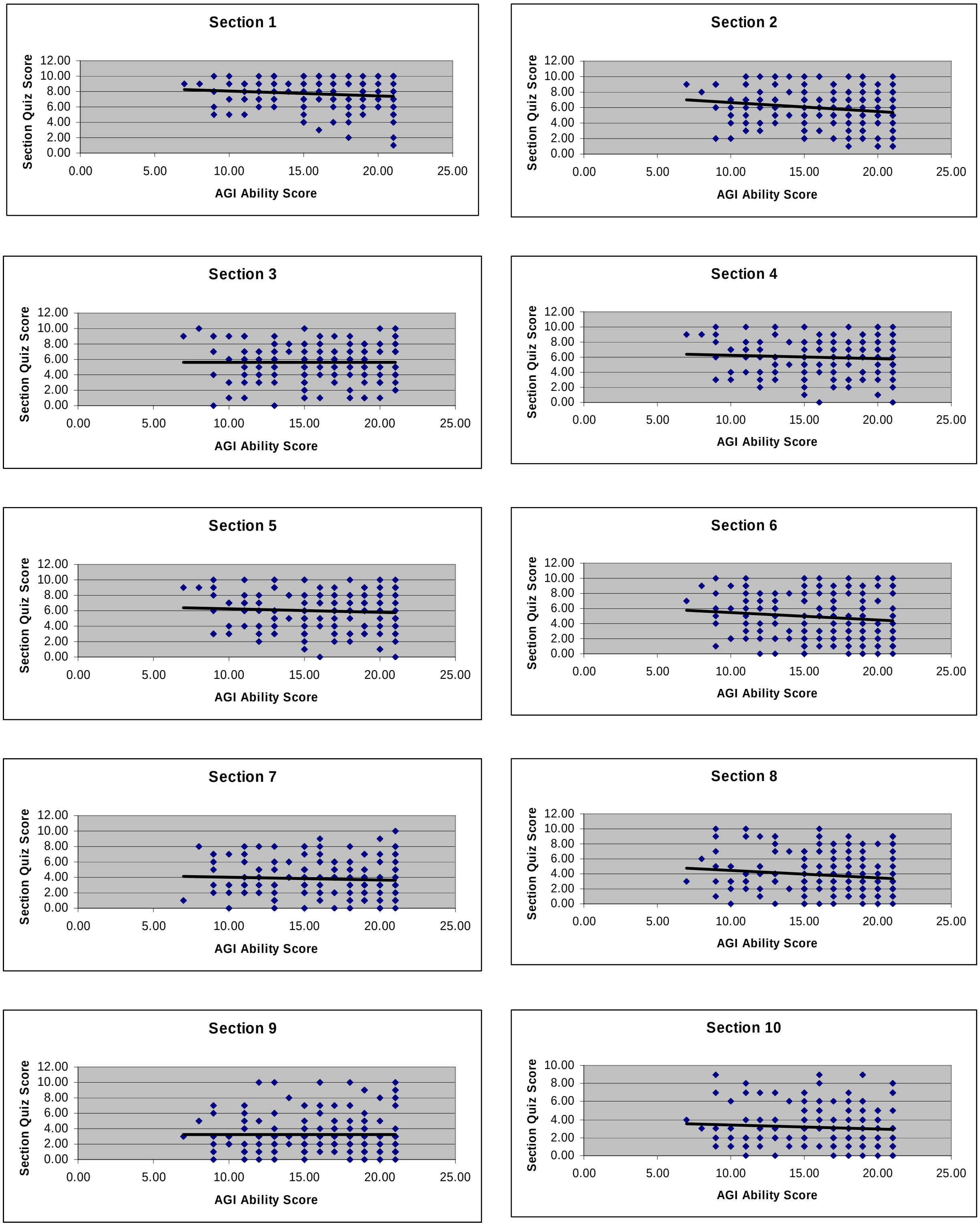

Figure 16. Regression of AGI Ability Score on each of the ten section quiz scores.

A significant yet small interaction was found between Tutorial Section, goal Message Frame, and AGI Ability score, F (8.842, 1308.649) = 1.93, p = .046, η_p^2=.013. As the tutorial progressed, participants in the below goal group who scored higher on the AGI Ability scale tended to obtain lower scores on the tutorial section quizzes, while the opposite was true of those in the above goal group. This effect peaked at the midpoint of the tutorial, and then began to diminish. Again, although the interaction was significant, strength of association was found to be quite weak. See Figure 17.

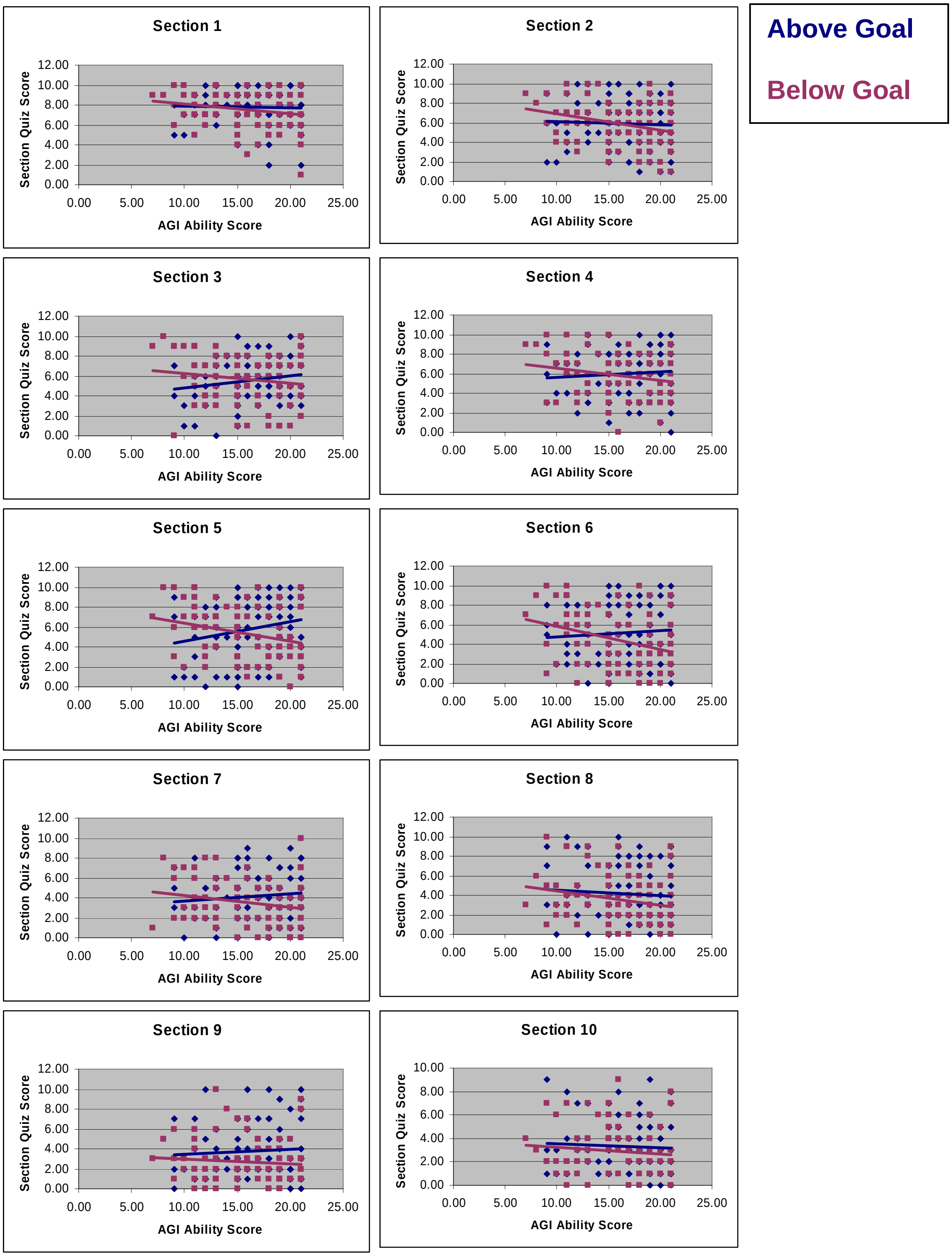

Figure 17. Regression of AGI Ability score on section quiz scores for each level of goal Message Frame.

Similar to the above interaction, a significant Tutorial Section X Goal Difficulty X AGI Ability score interaction was found, F (17.684, 1308.649) = 1.84, p=.018, η_p^2=.024. Regression lines for AGI Ability score on section quiz scores for each Goal Difficulty group on each section quiz are presented in Figure 19. As can be seen in Figure 18, students with a higher AGI Ability score in the improbable Goal Difficulty condition tended to score poorer on most, but not all, section quizzes. The opposite was true for participants in the easy goal condition, but only on the last two sections. Regression lines for participants in the challenging goal condition tended to follow those for the improbable goal condition but have lesser slope. Strength of association was found to be quite weak.

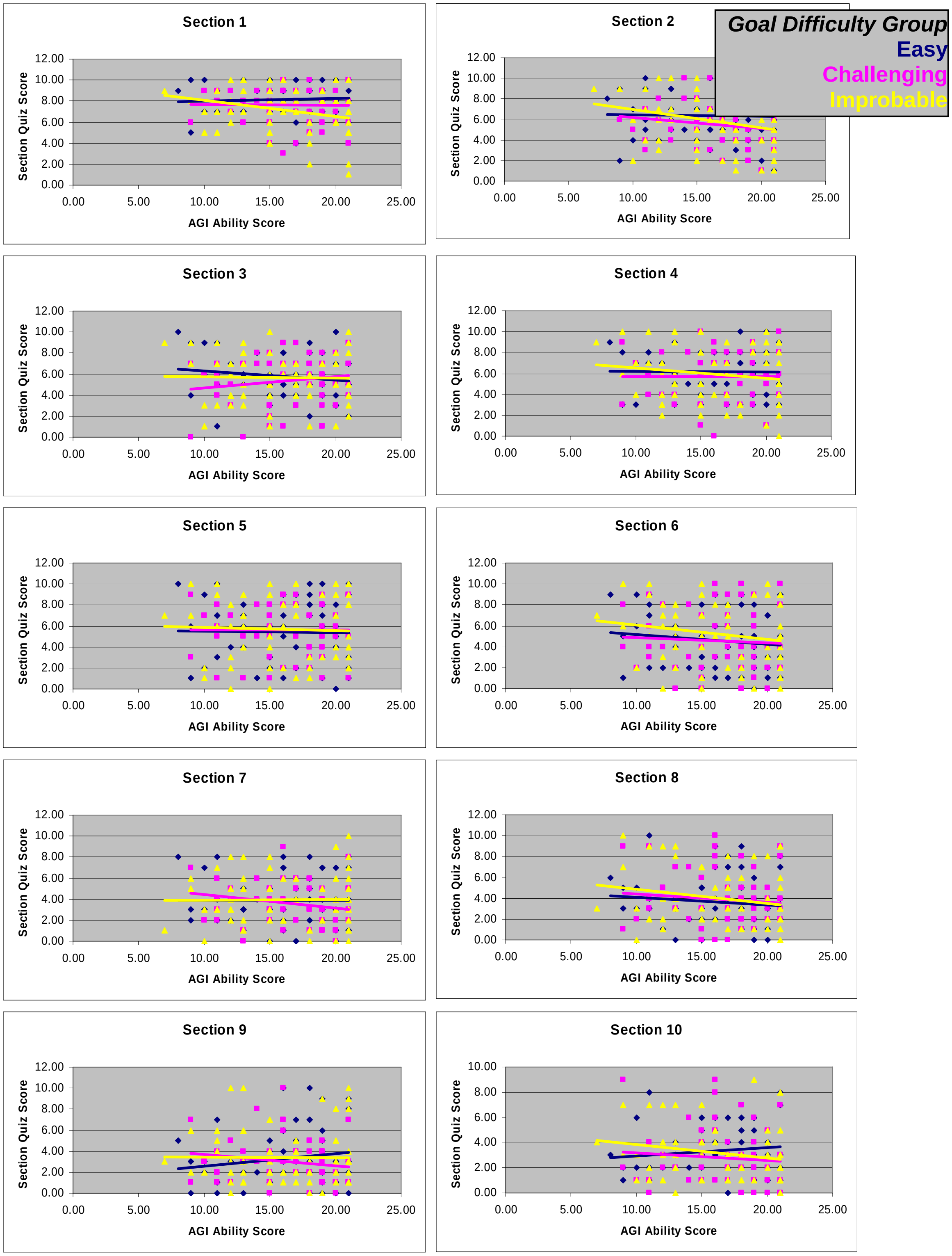

Figure 18. Regression of AGI Ability score on section quiz scores for each level of Goal Difficulty.

In addition to the Goal Difficulty X Tutorial Section interaction with AGI Ability score presented above, a Goal Difficulty X Tutorial Section X AGI Learning score interaction was found, F (17.684, 1308.649) = 1.84, p=.018, η_p^2=.024. Figure 19 displays a graph of the regression of AGI Learning scale scores on each section quiz score for each of the Goal Difficulty groups. In the first section, a small, positive relationship appears to exist between AGI Learning score and section quiz score for participants in the easy goal condition. Interestingly, as the tutorial progresses this relationship reverses with increasing slope until it reaches its maximum in section five, at which point the slope decreases until the relationship reverses once more in sections nine and ten. A nearly reverse pattern is seen for participants in the improbable Goal Difficulty condition. For participants in the challenging goal condition the relationship between AGI Learning score and section quiz scores tends to be either slightly negative or flat. As with the findings of significant effects reported previously, it is important to note that strength of association as measured by η_p^2 was found to be quite small.

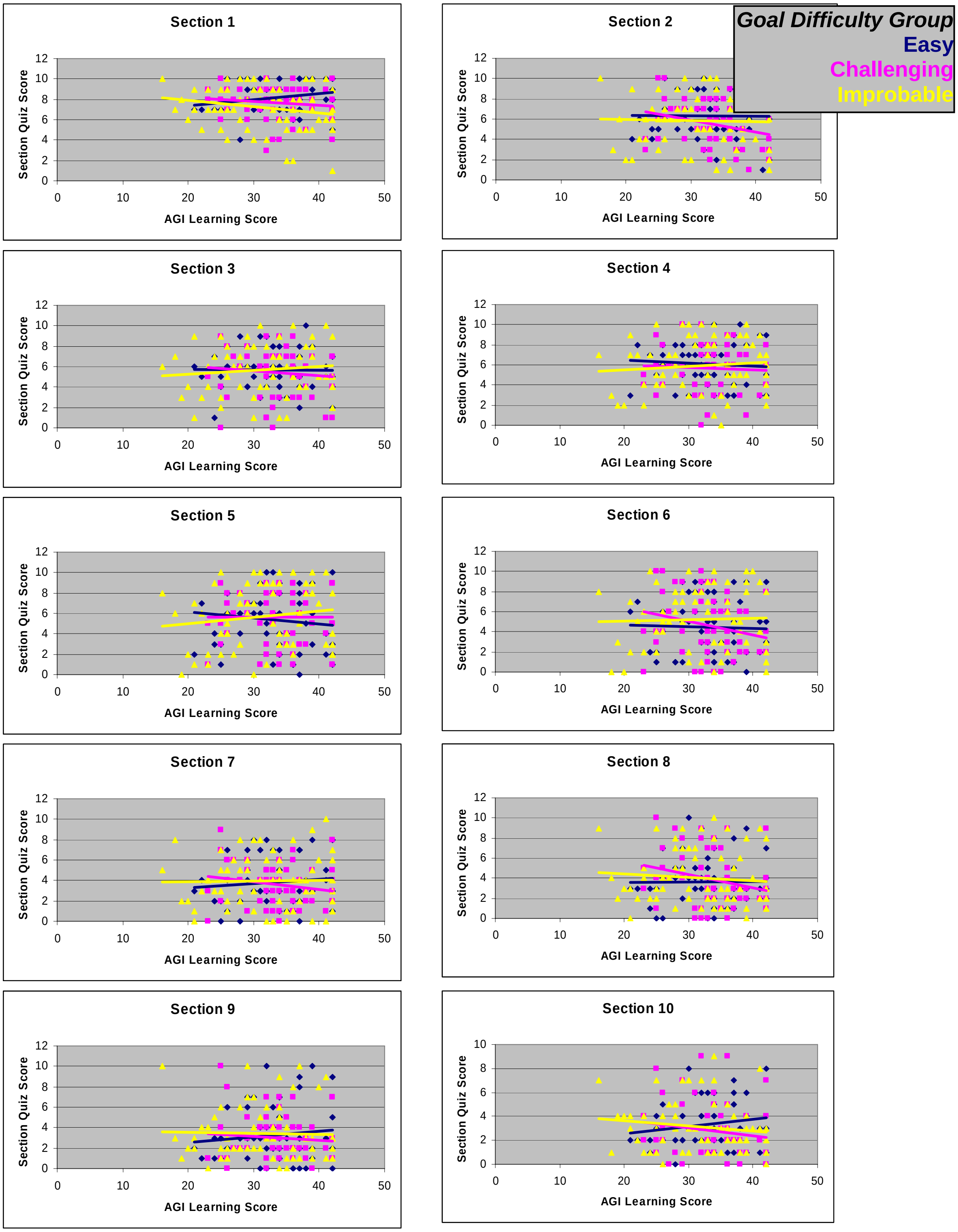

Figure 19. Regression of AGI Learning score on section quiz scores for each level of Goal Difficulty.

In addition to an analysis of performance, a one-way, repeated measures ANOVA was performed on section completion time (in seconds). Participants took successively less time to complete each section as the tutorial progressed, F (9, 1593) = 103.66, $p < .000$, $\eta_p^2 = .37$. As can be seen in Figure 20, participants spent on average nearly one fourth of the time to complete the final tutorial section as they did to complete the first section. Pairwise comparisons using the Bonferroni adjustment indicate significant differences (at $p < .05$) between all section times with the exception of sections 1 and 2, and sections 3 and 4.

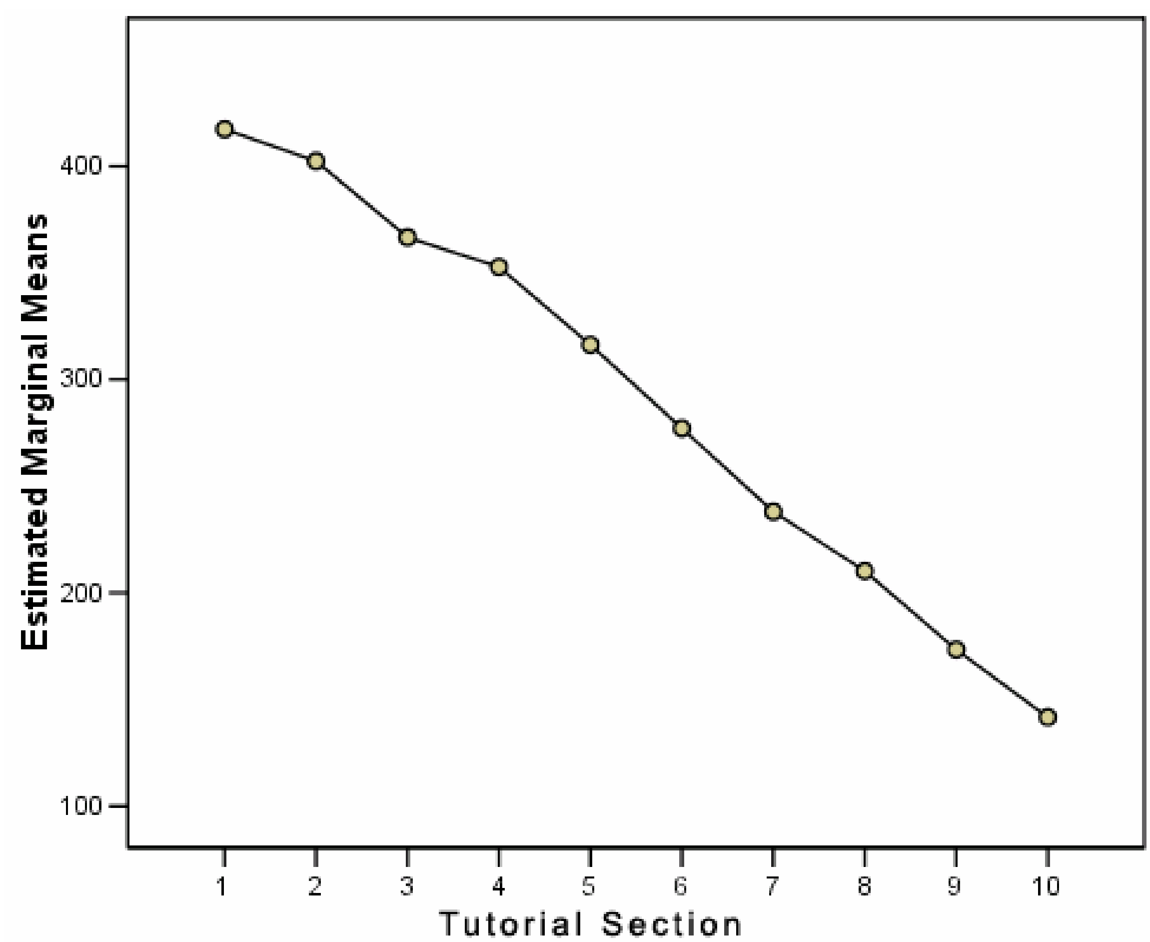

Figure 20. Mean section completion times (seconds).

Chapter Five: Discussion

The present study found that the effects of Message Frame and Goal Difficulty, when they occurred, were dependent on the goal orientation of the learner, and were generally small. Also, with the exception of Goal Difficulty, the ordinal position of a given quiz in the overall tutorial determined either whether a goal message would have an impact at all, or the direction that impact would take. As will be discussed later in this chapter, it is likely that goal commitment, as impacted by task interest (or a lack thereof), may have attenuated any effects of goal messaging.

Given the plethora of published results in support of Goal Setting Theory (GST) (such as the many studies summarized by Locke & Latham, 1990), the current findings are a bit surprising in that a main effect of Goal Difficulty was expected but not found. Goal difficulty had its greatest impact for students with a lower ability goal score, and the effect of Goal Difficulty when it did impact performance was a bit different than predicted, in that it was the improbable goal that lead to the best performance overall. Scores on the learning goal scale also impacted Goal Difficulty, again in an unexpected way. While students with a higher learning goal orientation score tended to score more highly on the first and last parts of the tutorial, it was those with a lower learning goal orientation who tended to score more highly on the middle-most sections.

As predicted, goal Message Frame had an impact on performance, but as with Goal Difficulty the effect was in an unexpected way. Like Goal Difficulty, by itself Message Frame did not have an effect. Unlike Goal Difficulty, it had the opposite effect for students scoring low on the ability goal scale than it did for students scoring high, but this effect was only observed during the middle of the tutorial, and not at the beginning or end.

Finally, of the five significant observed effects involving treatment variables, four were in interaction with Tutorial Section such that where treatment variables had an effect, the effect was present on some, but not all, tutorial sections. This, combined with the relatively small effect sizes, suggests that the effect of goal messaging on learning performance is quite a bit less dramatic than predicted, and certainly less so than other researchers (e.g. Locke & Latham, 1990) have found in the domain of work performance.

However, the experimental task used in the current study, as discussed previously, is qualitatively different from most studies supporting GST, in that it is strictly an instructional task rather than a work performance task. While it is possible that the impact of goals on learning tasks is simply not equatable with work performance tasks, a more parsimonious explanation may lie in the specific properties of the current task. Before considering the current findings in relation to Prospect Theory and the theoretical rationale underlying the original predictions, the first part of this discussion will focus on the most likely explanation for the current findings of small and/or attenuated effects of goal messaging in light of differences between the current experimental task and those found in the GST and other literature.

Goal Commitment

As stated by Locke and Latham (2002), the relationship between goals and performance is strongest when people are committed to their goals. Given the nature of the current experimental task, with its researcher-assigned goals, it seems reasonable to consider goal commitment (or lack thereof) as a possible explanation for the current findings. The studies reported by Locke and Latham (1990), and by Grant and Dweck (2003), for example, in which participants accepted and committed to task goals set by the researchers, used tasks that were likely much less cognitively demanding than the current study.

In a discussion of the nature of goal commitment, Locke and Latham (1990) define *goal acceptance* as a subtype of goal commitment which refers specifically to commitment to an assigned goal. The current study, then, is clearly focused on goal acceptance, as the stated tutorial quiz score goals were arbitrarily assigned by the researcher. However, although it seems reasonable to suspect that goal acceptance implies a lower level of commitment than might be expected from a self-selected goal, as in, "OK, I accept the goal (Locke & Latham, 1990, p. 125)", research has not found this to be the case. Early and Kanfer (as cited in Locke & Latham, 1990), for example, found that both commitment and acceptance measures formed one homogeneous index. While Locke and Latham (1990) clearly and explicitly acknowledge the potential differences between goal commitment for assigned vs. selected (both individually and participatively) goals, they consider these to be "subtle distinctions (p. 125)" that have not been shown to have any practical importance.

A potential clue may be gleaned from a study by Erez and Zidon (as cited in Locke & Latham, 1990). In this experimental study it was shown that goal commitment (and performance) decreased as task difficulty increased. It is possible that participants found the current task so difficult that the effects of motivation-enhancing variables had a tendency to simply wash out.

From an objective perspective it may seem a reasonable conclusion that the task was in fact quite difficult, given the mean overall score of 51 questions correct out of 100.

Also, task difficulty is a potential explanation for why nearly 20% of participants abandoned the tutorial before completing it. Finally, task difficulty could also explain the decrease in performance as the tutorial progressed – participants simply became increasingly fatigued. However, an argument against an explanation of the current findings in terms of task difficulty comes from the finding that the modal rating for the item *the tutorial was difficult* was "disagree."

While it is possible that the statement *the tutorial was difficult* was interpreted to refer to all aspects of the tutorial, such as the reading level of the text and the simple progression from one page to the next, rather than the intellectual difficulty in recalling the text content as quiz questions were presented, more likely perhaps is the conclusion that participants simply lost interest in the task as the tutorial progressed. The median intrinsic motivation score of 11 supports this contention. Recall that intrinsic motivation scores could range from a possible low score of 4 (indicating the highest level of intrinsic motivation) to 16 (indicating the lowest level of intrinsic motivation). Therefore a median score of 11 would presumably indicate that most participants found the tutorial somewhat less than stimulating. Lack of task interest is also perhaps why 20% of participants abandoned the tutorial before completing it. In addition, recall that for most groups section scores decreased as the tutorial progressed, to the point where scores on the last couple of sections were about what one would expect by chance. This, in combination with the finding of a nearly four-fold decrease in time spent on each tutorial from the first to the last, strongly suggests that participants tended to lose interest in the task, and by the end were simply clicking through at random.

Thus, a low level of goal commitment was almost certainly a factor in the present study. Any effects of goal messaging would likely therefore be attenuated or otherwise muted, and the current results should be considered in this light. Also, while the single direct measure of intrinsic motivation was made only at the completion of the tutorial, it seems reasonable to speculate, based on the nearly continuous decrease in both section scores and time spent as the tutorial progressed, that task interest also decreased in a linear fashion.

Learning Strategy Selection

In addition to challenges to goal commitment, task constraints on learning strategy selection may also be at work. As Nolen (1996) suggests, researchers should consider the importance of learning strategy selection in the service of learning goals. Nolen (1996) further suggests that goal acceptance itself involves a choice based on the relationship between effort and strategy use. From this perspective, a critical factor in the ability of assigned goals to impact performance is the availability (or at least perceived availability) of different learning strategies from which to choose. The current task, however, was quite constrained in this regard. As discussed earlier, the section quizzes were very much recall tasks. Participants had little leeway regarding learning strategy selection, other than an implicit but non-specific ability to choose to "try harder." Participants would have quickly realized this constraint as they completed the first section, and thus this constraint on strategy selection may very well have contributed to either a reduction in goal commitment, an increase in perceived task difficulty, or both.

Strategy selection has been demonstrated to be an important mechanism through which both goal orientations (Elliot, McGregor, and Gable, 1999; Ames and Archer, 1988), and goals themselves (Durham, Knight, and Locke, 1997), impact performance. Ames and Archer (1988) found that differences in assigned goals could impact performance, and that selection of more effective learning strategies are an important mechanism that allows this to happen. While Ames and Archer (1988) focused their investigation on the impact of perceived goal orientations of specific classroom environments, it nonetheless supports the idea that the constrained nature of the current task would limit the ability of assigned goals to elicit performance differences. Further support for this explanation comes from Elliot, et al. (1999), who state explicitly that an implicit assumption of achievement goal researchers is that study strategies mediate the relationship between achievement goals and performance.

While not including strategy selection as a direct mediator of goal effects, Locke and Latham (2002) state that goal effects are dependent on the ability to discover (and presumably use) appropriate task strategies. Durham, et al. (1997), in a study on the effects of goals on team performance and tactic use, found that goal effects were strongest when effective strategies were used. If it is in fact the case that goals exhibit their strongest (or at least *a strong*) influence on performance via their influence on strategy selection, then a learning task such as the current one would greatly constrain the ability of motivation-enhancing goals to exert their influence.

The Effect of Goal Orientation on Goal Messaging

Goal orientation, specifically ability goal orientation, was found to mediate the effects of all treatment variables, as well as the temporal effects of Tutorial Section. Of the three performance goal scales, only the Ability goal scale contains items which directly address self-efficacy in the context of the current task. Whereas the outcome goal scale addresses graded performance in a course, and the normative goal scale addresses graded performance compared to peers, the Ability goal scale taps the tendency to validate one's own intellectual ability through personal performance outcomes. Dweck and Leggett (1988) put such a tendency at the heart of a maladaptive personality structure associated with a "helpless" response pattern, and Locke and Latham (2002) view self-efficacy as an important factor in goal commitment. Bandura and Cervone (1986), and Bandura (1989) note that individuals with low self-efficacy are easily discouraged by failure. Bandura and Locke (2003), in a review of the literature, found that stronger self-efficacy works with personal goals to enhance performance. In the current task, the participants with the greatest tendency to hang self-efficacy on the rack of task performance would be the most likely to exhibit a decrease in performance in the face of evidence that performance was, or was likely to be, poor.

This explanation is supported by the finding of a main effect of AGI ability goal score. As participants scored higher on the ability scale, they tended to perform more poorly overall, as would be expected in a difficult task where only about half the quiz questions were answered correctly. This explanation is also supported by the interaction between AGI ability scale score and Goal Difficulty group. This tendency was most apparent for participants in the improbable and challenging goal conditions, whose performance grew poorer as an ability goal orientation grew stronger. Participants in the easy goal group, on the other hand, would likely reach their goal of 20% correct, and thus an ability goal orientation did not impact performance.

A Prospect Theory explanation of the above results, however, is a bit more problematic if we consider the value function as the arbiter of value for a given unit of work (i.e. Heath, et al. 1999). On the other hand, perhaps what the value function produces is more akin to degrees of emotional arousal, the manifestation of which is determined by higher-level processes (which could, and perhaps often does, take the form of work unit value). In this case, an ability goal orientation would tend to interpret the emotional arousal associated with being in the steeper part of the curve as an attack on self-efficacy, and the resulting helpless pattern of responding would lead to a decrease in performance. While we would expect an S-shaped curve to produce different degrees of arousal for participants in the challenging and improbable groups (which, recall, had similarly sloped regression lines), perhaps given the difficulty of the current task the subjective perception of distance from the goal was similar among these two groups.

Fluctuation of Effects Throughout the Tutorial

The effects of goal messaging and goal orientation were found to drift as participants moved from one tutorial section to the next, as one might expect if goal commitment also diminished throughout the tutorial. While a main effect was found of AGI Ability Goal scale score, this effect was attenuated by Tutorial Section, with four of the ten sections having regression lines with either minimal or no slope. Goal commitment, or lack thereof, may provide the simplest explanation for this, as it is reasonable to assume that a marginal commitment to the performance goal may cause the effects of that goal to wax and wane as the student progresses through the task. In the case of the two-way interaction between AGI Ability scale scores and Tutorial Section, there is no discernable pattern to this fluctuation, and is reasonably explained by a consistently low level of goal commitment.

A similar explanation can be given of the three-way interaction between AGI Ability score, Goal Difficulty, and Tutorial Section, in that the relationship between AGI Ability score and section quiz performance seems to wax and wane at random for each of the three Goal Difficulty groups. The easy Goal Difficulty group, however, appears to have the least movement between sections in the slope of the regression line of AGI Ability score on quiz performance. This group would be substantially more confidant that the performance goal would be reached, and thus less susceptible to emotional arousal from value function appraisals of goal distance.

However, a more unusual pattern emerged with the three-way interaction between AGI Ability score, goal Message Frame, and Tutorial Section. This is perhaps the most direct test of Prospect Theory (or at least the most traditional) as a theoretical rationale for goal effects in the current context, as it is an application of the well-documented framing effect to an instructional context. There is no apparent difference between Message Frame groups at the start of the tutorial, but a gradual increase of difference to the half-way point, then a gradual decrease until it completely disappears again by section ten. Interestingly, when the framing effect occurs, it occurs in the opposite direction for participants scoring high vs. low on the AGI Ability scale.

According to Prospect Theory, one might expect that participants starting the tutorial above the goal would feel the pain of losing points more intensely than those making an equivalent gain. In terms of performance, this might be expected to translate into enhanced motivation and thus increased performance when the goal is to avoid losing points rather than gaining points. However, if we consider the Prospect Theory value function in terms of emotional arousal rather than valuing of effort, then the impact of

Message Frame is determined by both the degree of arousal and the higher-level processes through which it flows. If one is below the goal, and facing the greater emotional arousal of the steep part of the curve, one of two things could happen. For one, this greater emotional arousal could manifest as a greater perception or expectancy of reward per unit effort (thus a greater valuing of each unit of work). Alternatively, the greater emotional arousal could manifest as anxiety, or another maladaptive response. In the case of participants with a higher ability goal orientation, with its accompanying tendency toward the helpless response pattern, perhaps it was the latter that occurred and led to decreased performance. For participants with a low ability goal orientation perhaps it was the former that occurred, and led to increased performance. In the above goal condition, with its shallower curve, emotional arousal was less intense, which led to increased performance for those with a higher ability goal orientation (and thus for whom meeting the performance goal had greater salience) and poorer performance for those with a lower ability goal orientation.

Implicit in the above argument is the idea that an appraisal of current position relative to the goal was made periodically, and perhaps frequently, throughout the tutorial, and that this appraisal fueled whatever processes were ultimately driven by the value function. As the tutorial progressed from section to section these appraisals would eventually indicate whether the goal was reasonably attainable, and whether or not it would be met before the end of the final section. In other words, at some point the *am I going to meet my goal?* question would be answered. Perhaps it was in section five where this question was answered for most participants, and thus where the salience of current position relative to the goal became most pronounced. Once this point had been reached, goal commitment would likely have begun to diminish, and would have continued to diminish throughout the remainder of the tutorial. As goal commitment weakened, the impact of goal messaging weakened.

This is consistent with the finding of a decreasing amount of time spent on each section, and the low level of intrinsic motivation at the end. At some point, perhaps section five, task interest may very well have reached a level where the impact of goal messaging simply began to wash out, and had vanished entirely by the final section.

The interaction between AGI learning goal scale scores and Goal Difficulty group were found to fluctuate across tutorial sections in a way similar to the interaction between ability goal scale scores and Goal Difficulty group. For the improbable Goal Difficulty group, in the first section participants scoring higher on the learning goal scale tended to score lower on the section quiz, but this trend reversed itself gradually, becoming most pronounced in section five. It then gradually reversed itself again, with the regression line for AGI learning scale score on the section ten quiz score having approximately the same slope and direction as that for section one.

The opposite pattern was seen for participants in the easy goal group, with those participants scoring high on the learning goal scale obtaining higher section one quiz scores. Again, this trend had reversed itself by section five, and then began to reverse again until the section ten regression line was quite similar to that for section one. Participants in the challenging Goal Difficulty group tended to exhibit either a flat or negative relationship between learning goal scale score and section quiz scores across all sections.

As Grant and Dweck (2003) note, wanting to do well in courses and getting good grades may be part of a learning goal as well as a performance goal, and that it is the reasons underlying this desire that separate the two. In section one, perhaps those with a stronger learning goal orientation and in the easy Goal Difficulty group were bolstered by their perception of a greater likelihood of successfully reaching the goal. By section five, the *am I going to meet my goal?* question would have been answered. For participants in the easy goal group, the goal would have been met and continued successful performance would be rewarding only for those who place an intrinsic value on content mastery, hence the better performance of higher learning goal scorers in the easy group on the final section quiz. For students in the improbable group, perhaps the perception of active learning regardless of whether the goal would be reached bolstered those with a stronger learning goal orientation. As the tutorial continued, perhaps these students looked to their failure to reach the goal as in indication of failure to master the material, and with no particular concern for performance simply stopped trying as hard.

Implications and Directions for Future Research

While the current study provides very limited support for an impact of goal messaging on motivation, it does underscore the importance of learner trait variables, specifically the goal orientations that learners bring with them to the instructional situation. The current findings strongly suggest that neither the impact nor direction of goal messaging framing or Goal Difficulty, when they have an effect, can be predicted without first understanding the specific goal orientation of a given learner, and how that learner will respond to increasing or decreasing distances above and below a goal.

Understanding the needs of the intended audience stands at the beginning of most all instructional design process models (such as, but not limited to, those of Dick, Carey, & Carey, 2001, and Alessi & Trollip, 2001). Especially in the case of individualized instruction, perhaps a form of computer mediation could be implemented where goal orientation could be measured and goals adjusted accordingly prior to the start of an instructional program.

The current study suggests several areas for future research. First, it is important to understand how goal commitment changes with changes in task difficulty, and how goal orientations come to bear on this process. How can goal commitment be maximized? Is greater goal commitment associated with a greater impact of goal messaging?

Also, future research should investigate the impact of assigned instructional performance goals on learning strategy selection, and how goal orientation impacts this process. Will some strategies be preferable to others depending on (including interactions between) goal difficulty, goal message framing, and goal orientation? Assuming that future research demonstrates goal orientation to impact learning, how can goal orientation be efficiently and accurately measured such that instruction can be manipulated or customized to best match the goal orientation of the learner?

Finally, while the current study does not negate Prospect Theory as a mechanism underlying the valuing of effort toward a goal, it demonstrates that much is missing. Is there a more accurate value function? What sequential or parallel processes combine with a/the value function to produce goal-related behavior?

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Appendices

Appendix A

Achievement Goal Inventory Items (from Grant & Dweck, 2003)

Outcome goal items

1. It is very important for me to do well in my courses.

2. I really want to get good grades in my classes.

3. A major goal I have in my courses is to perform really well.

Ability goal items

4. It is important for me to confirm my intelligence through my schoolwork.

5. In school I am focused on demonstrating my intellectual ability.

6. One of my important goals is to validate my intelligence through my schoolwork.

Learning goal items

7. I strive to constantly learn and improve in my courses.

8. I school I am always seeking opportunities to develop new skills and acquire new knowledge.

9. In my classes I focus on developing my abilities and acquiring new ones.

10. I seek out courses that I will find challenging.

11. I really enjoy facing challenges, and I seek out opportunities to do so in my courses.

12. It is very important to me to feel that my coursework offers me real challenges.

Normative goal items

13. It is very important for me to do well in my classes compared to others.

14. I try to do better in my classes than other students.

15. A major goal I have in my courses is to get higher grades than the other students.

16. It is very important for me to confirm that I am more intelligent than other students.

17. When I take a course in school, it is very important for me to validate that I am smarter than other students.

18. In school I am focused on demonstrating that I am smarter than other students.

Appendix B

Stimulus Development

The experimental tutorial was developed in three stages. The content is based on Ian Peter's (2005) *History of the Internet* Audio CD, Ebook, and Web site (and used by permission of the author).

In the first stage, 10 chapters from the original *History of the Internet* (Peter, 2005) were selected and re-worded slightly for clarity, consistency, and brevity, producing 10 text passages containing between 500 and 600 words. Six multiple choice questions were then created for each text passage.

These text passages and multiple choice questions were implemented in a Web-based tutorial consisting of 10 sections, each section containing one text passage followed by the six multiple choice questions based on it. Each text passage was divided approximately in half, and displayed on two contiguous, navigationally reciprocating pages. The second text page also contained a hyperlink to the section quiz.

Once the student left the text pages and began the section quiz, he or she could not return to the text pages. The quiz questions were presented in random order, one per page. Following the submission of each answer, a feedback page was displayed. Question pages where presented in a page-forward manner only; once answered, the student could not return to the question. At the end of each section quiz a section summary was displayed summarizing the student's quiz performance for the section just completed and performance overall.

In addition to section text and quiz questions, each page contained a goal message statement in the upper left corner, and a performance summary in the upper right corner.

(See Figure B1 for a sample feedback page following the submission of a section quiz response, Figure B2 for a sample section text page, and Figure B3 for a sample section performance summary.)

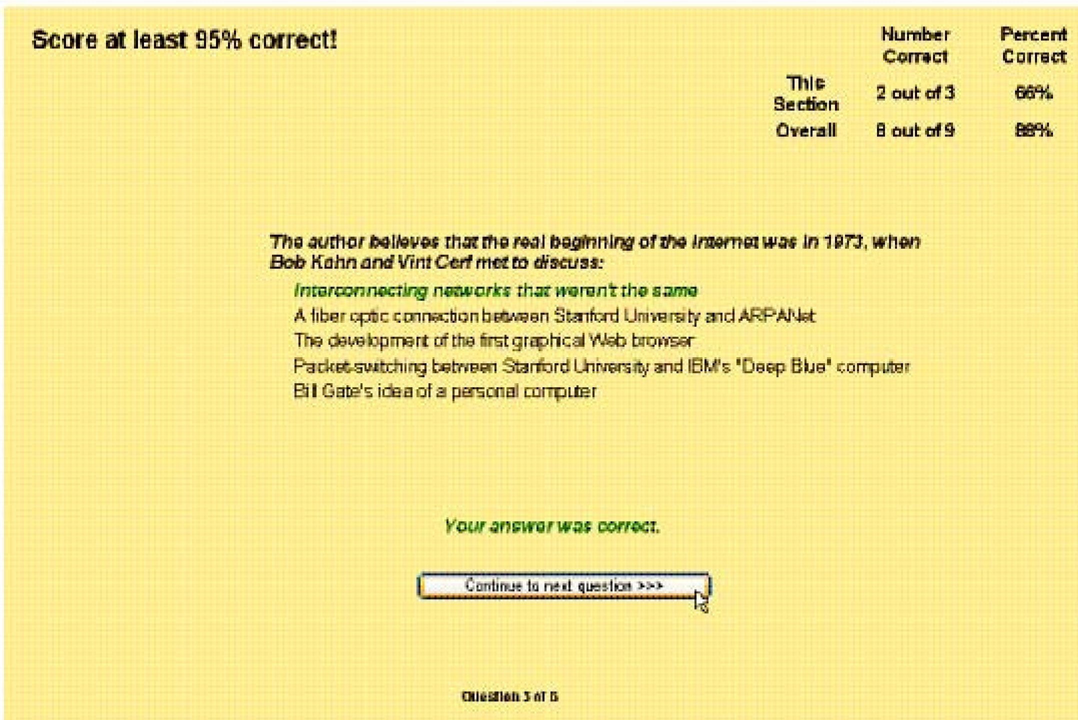

Figure B1. Sample quiz item feedback following a correct response, stage 1.

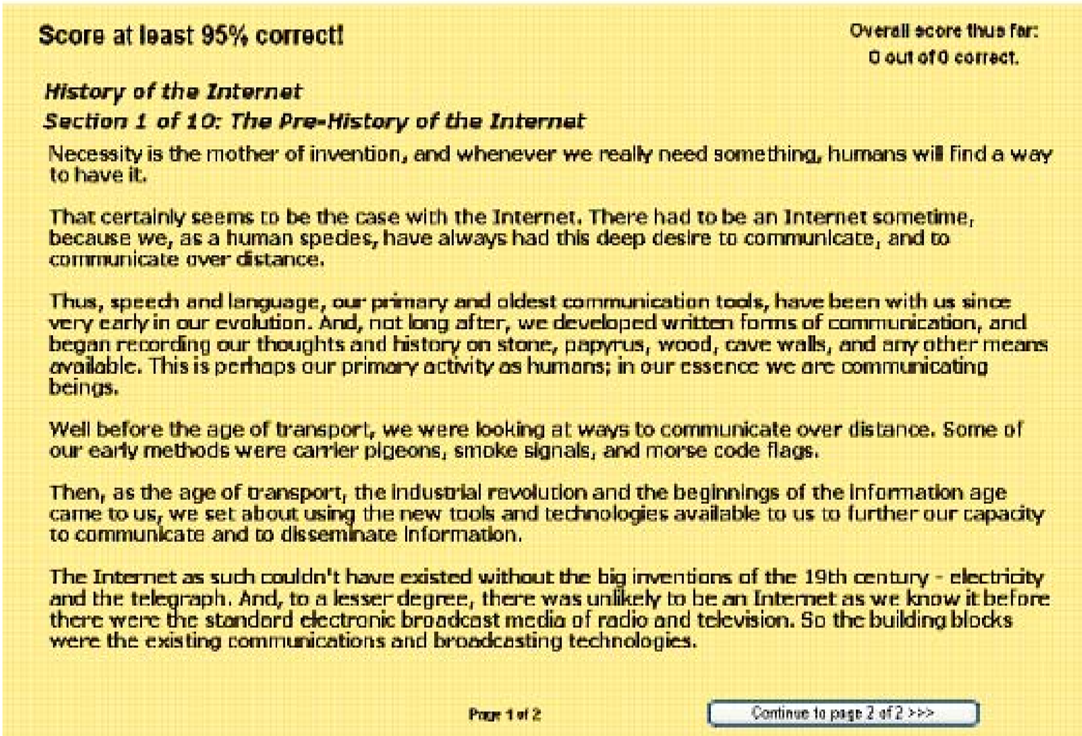

Figure B2. Sample tutorial text page, stage 1.

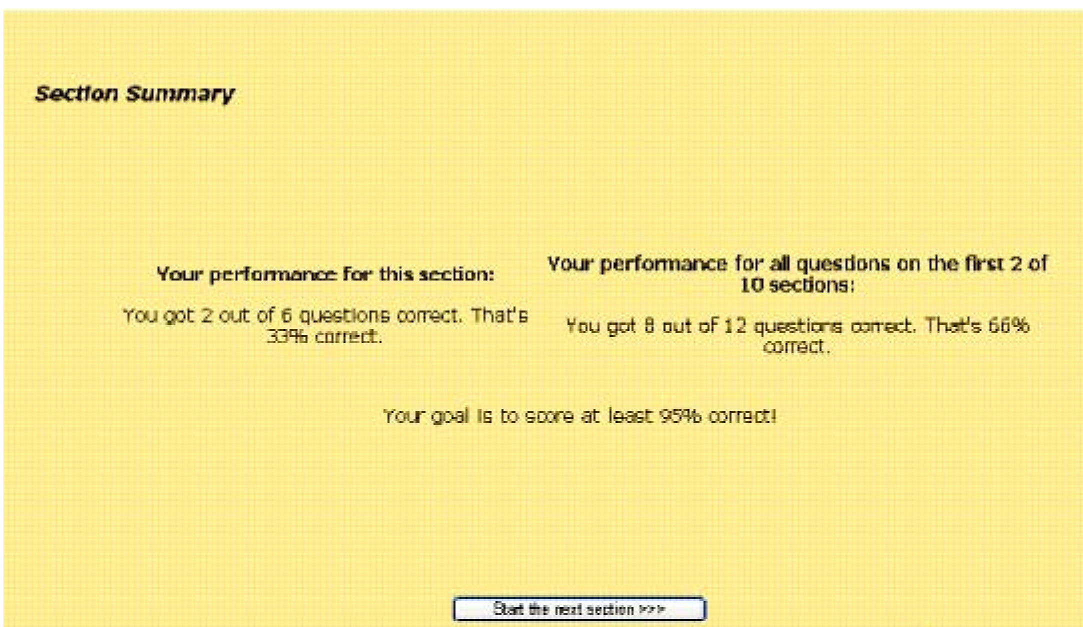

Figure B3. Sample section summary, stage 1.

In order to clear rehearsal memory, a number sorting task was presented just prior to the multiple choice questions for each section. This number sorting task required the subject to sort in ascending order five randomly-generated floating point numbers between one and 10000.

Prior to the start of section 1, participants are asked to enter their age, major, gender, and number of years in college. Following this, an instruction screen is presented giving the participants a brief overview of the tutorial format and re-stating the following verbal instructions:

> Your final score will not be reported to your instructor. Your instructor will only know whether or not you completed the entire tutorial. You must complete the entire tutorial to receive extra credit.

This text was followed by a goal statement. Participants were randomly assigned to one of two goal conditions: a “do your best” (DYB) condition, in which participants were told that their goal should be to do their best on the tutorial, and a difficult condition, in which participants were told that their goal should be to score at least 95% correct overall on the tutorial. This message was repeated as either “Do your best!” or “Score at least 95% correct!” on all subsequent tutorial pages (with the exception of the sorting task page).

After completing the tenth and final section, participants were asked to rate their agreement on a four-point Likert-type scale with each of seven statements. The first four were intrinsic motivation items (from Elliot & Church, 1997; Grant & Dweck, 2003): a) “I thought the tutorial was very interesting,” b) “the tutorial was a waste of time,” c) “the tutorial was boring,” and d) “I enjoyed the tutorial very much.” Following the intrinsic motivation items were two difficulty items: a) “the tutorial was difficult,” and b) “the tutorial was challenging." Last was the statement "I learned a lot from the tutorial."

In addition to recording section quiz scores, the length of time in milliseconds each page was displayed in the Web browser was also recorded.

The tutorial was administered to 70 students enrolled in a freshman Introduction to Computers and Technology course at a community college in Tampa, Florida. The history of the Internet is a topic normally covered in this course, and the tutorial was administered during a regularly scheduled class meeting. Data from four students were discarded: two students quit the tutorial before completing it, and two students were minors. Of the 66 participants remaining in the sample, 30 were female and 36 male, with a mean age of 20.

The tutorial proved to be difficult for most participants, with an overall mean total score of 30 out of 60 items correct (*SD* = 8.71), and a range of 17 to 55. The distribution of scores was found to be slightly skewed toward the lower range (see Figure B4).

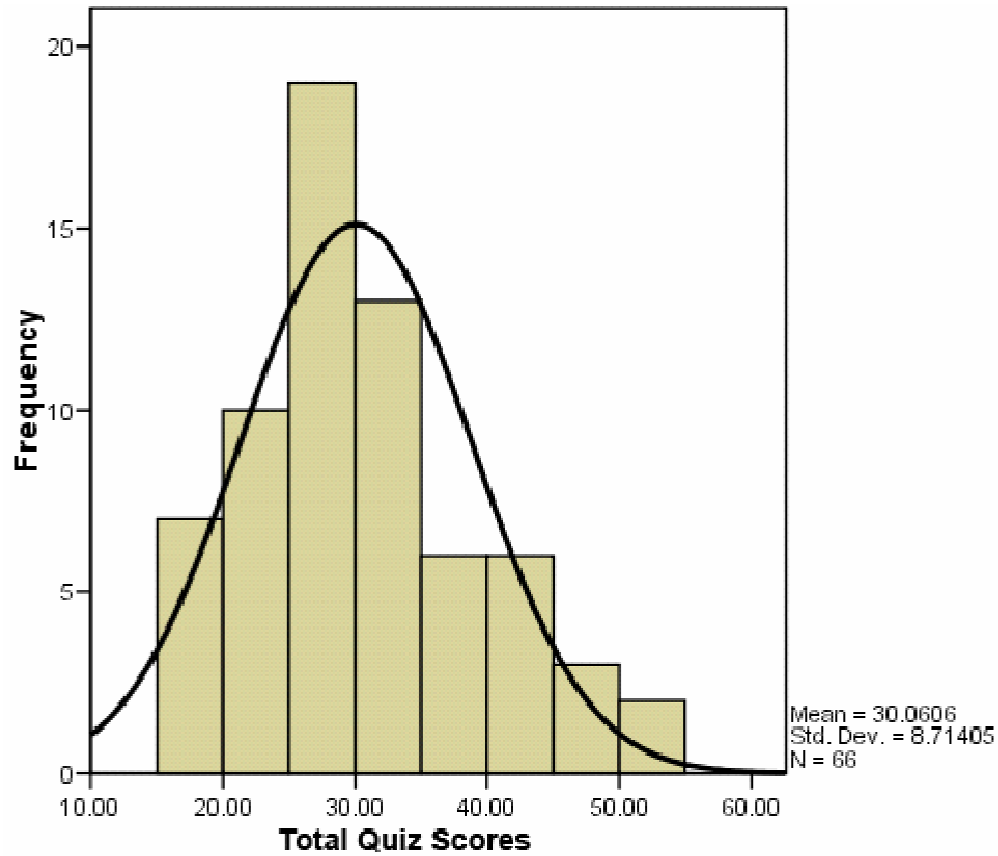

Figure B4. Distribution of stage 1 overall quiz scores.

KR-20 values for the individual section quizzes are displayed in Table 1, and ranged from .1 to .58.

Table B1

KR-20 values for each of the 10 section quizzes in Stage 1.

Section	1	2	3	4	5	6	7	8	9	10
KR-20	.427	.47	.538	.1	.24	.58	.412	.58	.468	.28

As the internal consistency of section quiz scores was generally found to be less than adequate, quiz scores were not used to analyze differences between goal conditions.

Total page view times for each section were analyzed in a 2 Goal Message (DYB vs. difficult) x 10 Tutorial Section mixed-model ANOVA. A main effect of Tutorial Section was found to be significant, $F(9,56) = 15.6$, $p < .001$. Page view times tended to become shorter as the tutorial progressed (see Figure B5), likely due to fatigue.

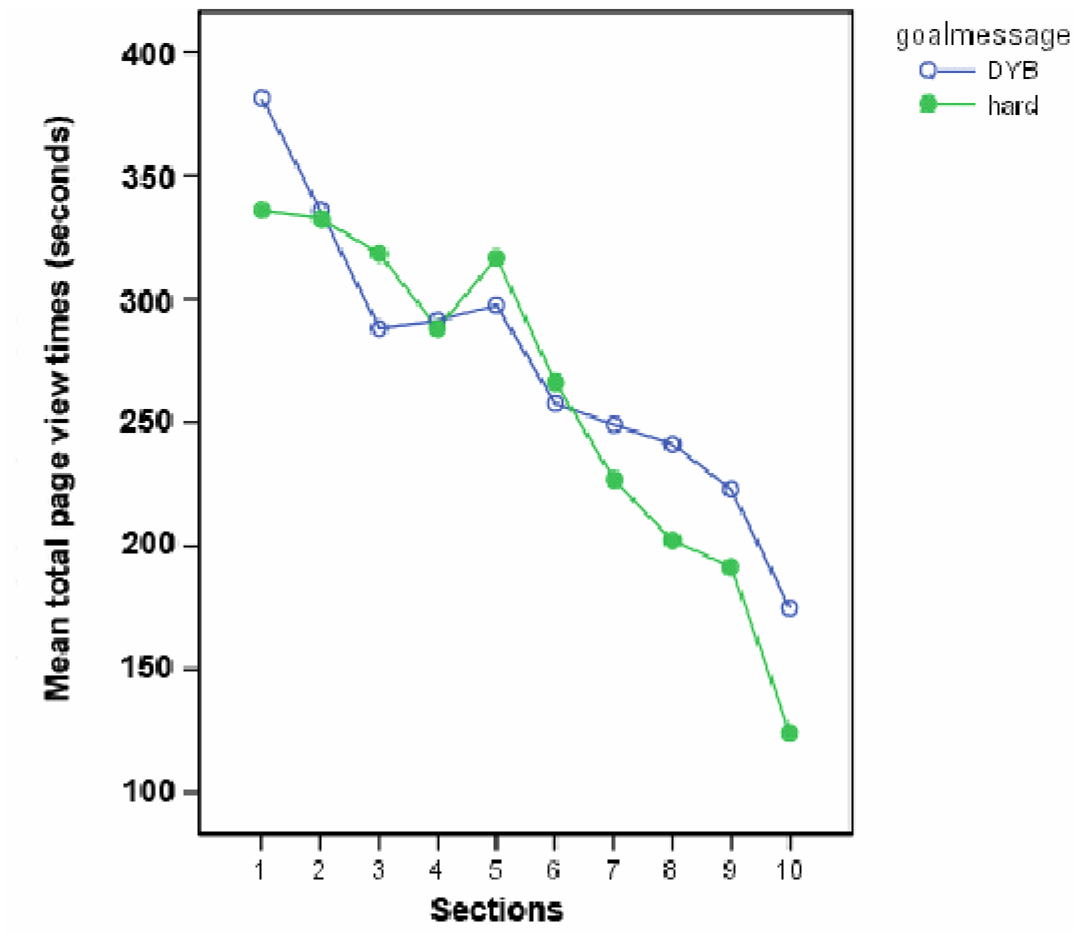

Figure B5. Page view times for each Tutorial Section X Goal Message.

Section quiz scores were also analyzed in a 2 Goal Message (DYB vs. difficult) x 10 Tutorial Section mixed-model ANOVA. As with page view times, Tutorial Section was found to have a significant effect on quiz scores, with quiz scores becoming poorer as the tutorial progressed, $F(9,56) = 19.8$, $p < .001$.

As the internal consistency of the section quiz items was generally poor, group differences were not considered on section quiz scores.

While goal message produced no differences on either difficulty rating or rating of amount learned, the DYB group scored significantly higher on the intrinsic motivation items, $F(1,63) = 4.6$, $p < .05$, $d = .53$, with a mean intrinsic motivation score of 8.6 (out of a possible 16) compared to 7.4 for the difficult group.

An item analysis was conducted on each section quiz score, and all items with an item-to-total correlation of less than .2 were either reworded or removed entirely. In addition, text passages which directly related to poor quiz items were reworded for clarity. Finally, additional quiz items were constructed to produce 10 items per quiz, for a total of 100 quiz items.

This second stage version of the tutorial was delivered to 51 students within the same population as the earlier group but who had not seen the earlier version. As with the stage 1 version, stage 2 version scores tended to indicate a difficult task (mean=50.27, median=52, mode=52, SD=20). Scores tended to distribute fairly normally (see Figure B6).

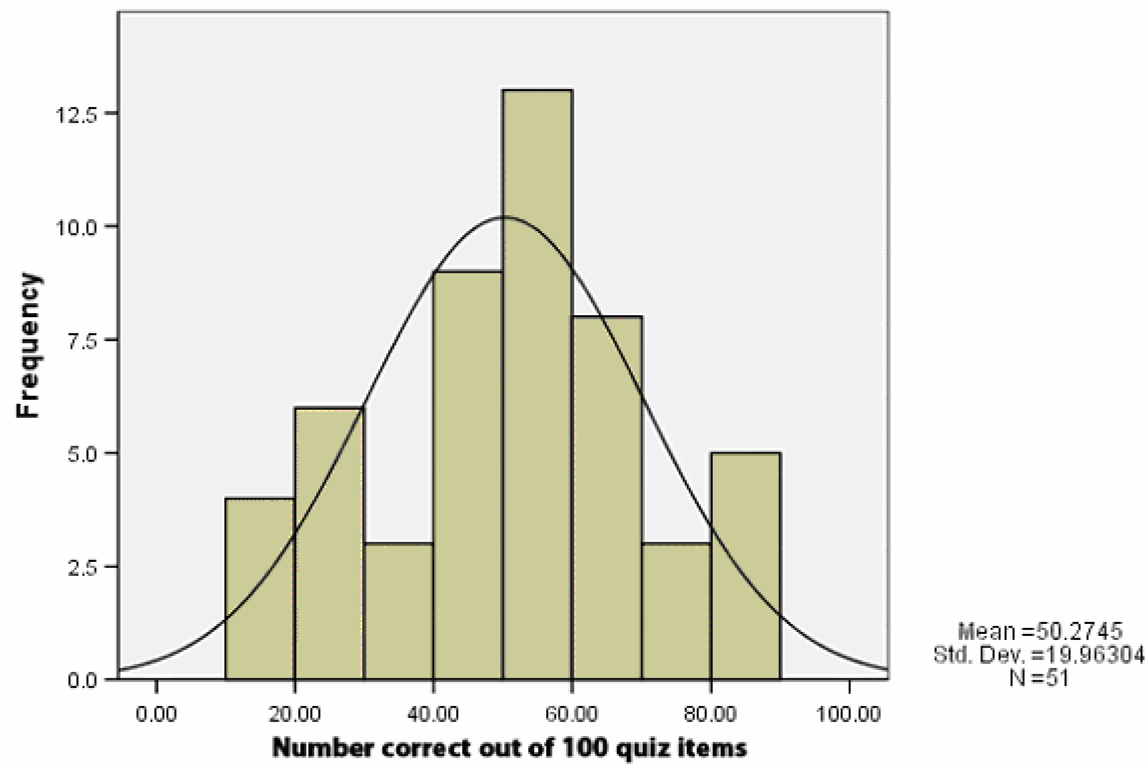

Figure B6. Distribution of overall stage 2 scores.

10 percent of students were found to score below 20 % correct, 90% were found to score below 80% correct, and no student scored above 92% correct.

Internal consistency of the section quiz items was found to be much more acceptable than those found for the stage 1 version, with KR-20 values ranging from .59 to .79 (see Table 2).

Table B2.

KR-20 values for each of the 10 section quizzes in Stage 2.

Section	1	2	3	4	5	6	7	8	9	10
KR-20	.73	.77	.69	.74	.79	.79	.59	.74	.75	.67

In addition to the above measure of reliability, 16 judges were randomly assigned to evaluate one half of the tutorial. Judges were members of the same population as the students taking the tutorial. Each judge was given the complete text of each section, the questions in the section quiz along with the scored answers, and asked to rate each question on a 5-point scale ranging from 1 = *Question IS NOT a good one* to 5 = *Question IS a good one*. Judges were given the following explicit instructions:

> There is not necessarily a "right" or "wrong" rating. You should just use your best judgment, and consider what the text actually says, what the question asks, what the possible answers are, and what the response marked correct is. Again, your job is to help us determine how well each question fairly and adequately indicates whether someone has read and understands the text passages. If you were answering these questions for a grade, what would you think about them?

In addition to this Likert-type rating, judges were also asked to provide an open-ended response to any question they might wish to comment on. Judges were able to freely browse between the section text and all section quiz questions.

Generally, item ratings were quite positive, with a mean of 4.15, a median of 4.0, a mode of 5, and a SD of .975.

Section quiz items were again evaluated based on their individual item-to-total correlations, their average rating by the judges, and any negative open-ended comments made by the judges. Eight quiz items were found to be less than adequate according to at least two of these measurements. Based on the open-ended comments for the quiz item, and a further assessment by the experimenter, the quiz item itself was re-worded, the text passage on which the quiz item was based was re-worded, or both.

A final version was thus produced consisting of 10 sections, each section consisting of a 500 to 600 word, two-page text passage followed by a 10 multiple-choice item section quiz. The text passages and quiz items can be found in Appendix C.

Appendix C

Text content and quiz items of *History of the Internet* experimental tutorial

Text Content

Section 1

Title: The Pre-History of the Internet

Page 1 Text:
Necessity is the mother of invention, and whenever we really need something, humans will find a way to have it.

That certainly seems to be the case with the Internet. There had to be an Internet sometime, because we, as a human species, have always had this deep desire to communicate, and to communicate over distance.

Thus, speech and language, our primary and oldest communication tools, have been with us since very early in our evolution. And, not long after, we developed written forms of communication, and began recording our thoughts and history on stone, papyrus, wood, cave walls, and any other means available. This is perhaps our primary activity as humans; in our essence we are communicating beings.

Well before the age of transport, we were looking at ways to communicate over distance. Some of our early methods were carrier pigeons, smoke signals, and morse code flags.

Then, as the age of transport, the industrial revolution and the beginnings of the information age came to us, we set about using the new tools and technologies available to us to further our capacity to communicate and to disseminate information.

The Internet as such couldn't have existed without the big inventions of the 19th century - electricity and the telegraph. And, to a lesser degree, there was unlikely to be an Internet as we know it before there were the standard electronic broadcast media of radio and television. So the building blocks were the existing communications and broadcasting technologies.

Page 2 Text:
Electronic networks began with the telephone, or telegraph system as it was known in the beginning. Here the origins are pretty clear - the first line was built in 1844 from Washington to Baltimore. By 1858 a transatlantic cable was in place, and by 1861 - a mere seventeen years after the first connection - telegraph wires covered the USA.

As Marshall McLuhan notes in his 1960s classic, Understanding Media, new technologies are often much misunderstood during their early development:

It is instructive to follow the embryonic stages of any new growth, for during this period of development it is much misunderstood, whether it be printing or the motor car or TV.

For instance, the early motor car was called the horseless carriage - and most people of that day saw only that the motor vehicle would do what the horse and carriage had done before it. No-one was envisaging aeroplanes, long distance trucks, high speed highways and cars, intercontinental travel, and the other advances that came from this base discovery - people just looked at this as a way to get to town to go shopping.

We see something similar in the case of the telephone system. In the earliest days, people saw its uses as being of a broadcast nature - one way communications. A little later, people thought it would be good for sending Morse code messages.

Within 150 years of its first beginnings, the telegraph network infrastructure had become the biggest single connected construction on the planet - and off the planet as well! This is the physical infrastructure on which the Internet was built, and on which it relies. This infrastructure also explains the historical role of telecommunications companies in the Internet.

Section 2

Title: The Beginnings of the Internet

Page 1 Text:
It will help in discussing the beginnings of the Internet to define what the Internet is. Now you can get as many different definitions of what the Internet is as you can dictionaries. But for must of us, the simple description, a worldwide system of interconnected networks and computers is pretty good and adequate. More technically, you could call it the global network that uses the Transmission Control Protocol - Internet protocol (or TCP/IP).

Bob Taylor, the Pentagon official who was in charge of the Pentagon's Advanced Research Projects Agency Network (or Arpanet) program, established in 1969, insists that the purpose was not military, but scientific. A nuclear attack theory was never part of the design. Nor was an Internet in the sense we know it part of the Pentagon's 1969 thinking. Larry Roberts, who was employed by Bob Taylor to build the Arpanet network, states that Arpanet was never intended to link people or be a communications and information facility.

Arpanet was about time-sharing. Time sharing tried to make it possible for research institutions to use the processing power of other institutions computers when they had large calculations to do that required more power, or when someone else's facility might do the job better.

What Arpanet did in 1969 that was important was to develop a variation of a technique called packet switching. In 1965, before Arpanet came into existence, an Englishman called

Donald Davies developed the concept of packet switching, a means by which messages can travel from point to point across a network. Although others in the USA were working on packet switching techniques at the same time (notably Leonard Kleinrock and Paul Baran), it was the UK version that Arpanet first adopted.

Page 2 Text:
TCP/IP is the backbone protocol which technical people claim is the basis for determining what the Internet is. It was developed in the 1970s in California by Vinton Cerf, Bob Kahn, Bob Braden, Jon Postel and other members of the Networking Group headed by Steve Crocker and consisting of mostly university researchers and non-military computer professionals. TCP/IP was developed to solve problems with earlier attempts at communication between computers undertaken by ARPANET.

Bob Kahn visited Stanford in the spring of 1973 and he and Vint Cerf discussed the problem of interconnecting multiple packet networks that were NOT identical. They developed the basic concepts of TCP at that time, and presented it to the newly established International Networking Group. This meeting and this development really rates as the beginning of the Internet.

Nobody knows who first used the word Internet - it just became a shortcut around this time for internetworking. The earliest written use of the word appears to be by Vint Cerf in 1974.

By 1975 the first prototype was being tested. A few more years were spent on technical development, and in 1978 TCP/IPv4 was released.

It would be some time before it became available to the rest of us. In fact, TCP/IP was not even added to Arpanet officially until 1983.

So we can see that the Internet began as an unanticipated result of an unsuccessful military and academic research program component, and was more a product of cooperation between university researchers and non-military computer professionals.

Section 3

Title: The Multiple Origins of the Internet

Page 1 Text
So, who really did invent the Internet? History shows that it was many people and many groups.

A popular belief has sprung up that the Internet was invented in the Pentagon in 1969. The theory goes on to suggest that the Internet network invented in the Pentagon was designed to survive a nuclear attack.

This theory survives and is even propagated by individuals who celebrated the Internet's 35th birthday in 2004. However, not everyone celebrated, and not everyone agreed.

Perhaps the most serious rebuttal on the theory of Pentagon origins (otherwise known as the big bang theory of Internet origins) came from the person who was in charge of the Pentagon Arpanet project at the time when the Internet supposedly began, Bob Taylor. Writing in reference to a mailing list invitation to attend the 35th anniversary event, Bob Taylor explained.

In February of 1966 I initiated the ARPAnet project. I was Director of ARPA's Information Processing Techniques Office (IPTO) from late '65 to late '69. There were only two people involved in the decision to launch the ARPAnet: my boss, the Director of ARPA Charles Herzfeld, and me….Numerous untruths have been disseminated about events surrounding the origins of the ARPAnet. Here are some facts…. The creation of the ARPAnet was not motivated by considerations of war…… The ARPAnet was not an internet. An internet is a connection between two or more computer networks.

So where and when did the Internet begin? The only thing historians seem to agree on is that it was not 1969, or the Pentagon.

Page 2 Text
The following historical developments eventually came together to form the Internet as we now know it.

Packet Switching: In the mid-1960's Donald Davies from the UK developed and tested the concept of packet switching, a means by which messages can travel from point to point across a network. This was adopted by Arpanet.

TCP/IP: Building on the concept of packet switching, in October 1972 ARPANET demonstrated a pre-TCP/IP system for the first time. By 1975 a TCP/IP prototype was tested, and TCP/IP v4 (currently the most widely used version) was released in 1978. TCP/IP can be thought of as the language computers and other devices use to communicate on the Internet.

Telecommunications companies: Prior to and during the development of packet switching and TCP/IP, the major telecommunications companies provided technologies and infrastructure that made this development possible.

Network applications: In addition, online services such as Compuserve, Dialcom, Fidonet, etc. provided early models of computer-based communication networks that provided the application models, such as email, later implemented on the Internet.

Xerox PARC: Finally, the graphical user interface and ethernet, both used by the vast majority of Internet users today, would not have been possible without the work of Xerox PARC in the early 70's.

If anything, the history of the Internet is the history of an era.

Section 4

Title: A Brief History of the Personal Computer

Page 1 Text:
The explosion of internetworking can trace its origins all the way back to World War II, when both the UK government, in the form of a computer called Colossus, and the US government in the form of ENIAC (or the Electronic Numerical Integrator Analyzer and Computer) developed precursors of todays computers.

The sort of computers Arpanet and the early research networks were dealing with were monsters with very little power by today's standards. Only computer scientists used them. Computers with the power of modern day pocket calculators occupied whole floors of buildings. It was the development of the personal computer that made the Internet accessible to everyone.

The first personal computer, the Altair 8800, cost 379 US dollars and was shipped in January 1975. By 1977 The Radio Shack TRS 80, Apple 2, and Commodore PET were also on the market. IBM got the idea by about 1981 and released the first IBM PC.

The original Apple operating system was called AppleDOS, but by 1980 the CP/M operating system had become a popular addition to the Apple 2+. It was very like the competitor which was to overtake it and launch Bill Gates on the way to his fortune, MSDOS. In fact, MS-DOS's predecessor was called Q-DOS - short for Quick and Dirty Operating System.

None of these computers had been designed to be communicating devices. Here two more developments became important - the modem, which connected early computers to telephone lines, and Ethernet, a standard which was developed for Local area networks or LANs (where computers were really all in the same room or area and could be wired together).

Page 2 Text
Modem is a term we are likely to forget soon in the digital age, but for most of us modems were where internetworking began. Modem is short for modulate-demodulate. Modems work by turning the digital signals used by computers into analog signals that can be sent over telephone lines.

There were apparently some early modems used by the US Air Force in the 1950's, but the first commercial ones were made a decade later. The earliest modems were 75 bps (or bits per second). The modems used by early networking enthusiasts were 300 bps. Then came 1200, and by 1989 2400 bps modems.

By 1994, domestic modems had got to 28.8 kilobits per second, and later 56k bps pushing the envelope of the capacity of the telephone system.

The trend currently is wireless networks and broadband systems, which allow much faster speeds. But modems made the first critical link between computers and telephones, and began the age of internetworking.

Another important development used by most wireless and broadband systems was Ethernet, developed by 3-Com. Ethernet made a version of the packet switching and Internet protocols being developed for Arpanet available to cabled networks. Ethernet products became available on the commercial market in the early 1980's.

As the networks grew, other companies such as Novell and CISCO began to develop more complex networking hubs, bridges, routers and other equipment. By the mid 1980's, everything that was needed for an explosion of internetworking was in place.

Section 5

Title: The History of Email

Page 1 Text

Email is much older than ARPANet or the Internet. It was never invented; it evolved from very simple beginnings.

Early email was just a small advance on what we know these days as a file directory - it just put a message in another user's directory in a spot where they could see it when they logged in. Simple as that. Just like leaving a note on someone's desk. Probably the first email system of this type was MAILBOX, used at Massachusetts Institute of Technology from 1965. Another early program to send messages on the same computer was called SNDMSG.

It's important to remember that email at this time was used to send messages only to users of a single mainframe computer. Once computers began to talk to each other over networks, however, we needed to be able to address messages much like a postal letter and send them from one user to another user on a different network.

Ray Tomlinson, an Arpanet contractor, is credited with inventing a form email in 1972 that could send messages from one network to another. He picked the @ symbol from the computer keyboard to denote sending messages from one computer to another. By 1974 there were hundreds of military users of email because ARPANET eventually encouraged it. Email became the saviour of Arpanet, and caused a radical shift in Arpanet's purpose.

One of the first new developments when personal computers came on the scene was offline readers. Offline readers allowed email users to store their email on their own personal computers, and then read it and prepare replies without actually being connected to the network - sort of like Microsoft Outlook can do today.

Page 2 Text
This was particularly useful in parts of the world where telephone costs to the nearest email system were expensive. Offline readers were also useful because the offline mode allowed for more friendly interfaces for creating and reading messages, as this was an era of few standards.

The first important email standard was called SMTP, or simple message transfer protocol. SMTP was very simple and is still in use - however, as we will hear later in this series, SMTP was a fairly naive protocol, and made no attempt to find out whether the person claiming to send a message was the person they purported to be. This aspect of the protocol was later to be exploited by security frauds and spammers forging identities. This is a problem still being addressed today.

When Internet standards for email began to mature the POP (or Post Office Protocol) servers began to appear as a standard - before that each server was a little different. POP was an important standard to allow users to develop mail systems that would work with each other.

These were the days of per-minute charges for email for individual dialup users. For most people on the Internet in those days email and email discussion groups were the main uses. There were many hundreds of these on a wide variety of topics, and as a body of newsgroups they became known as USENET.

With the World Wide Web, email started to be made available with friendly web interfaces by providers such as Yahoo and Hotmail. Usually this was without charge. Now that email was affordable, everyone wanted at least one email address, and the medium was adopted by not just millions, but hundreds of millions of people.

Section 6

Title: The History of the World Wide Web

Page 1 Text:
Before the World Wide Web the Internet really only provided screens full of text. Although a very powerful and rich information environment, it was visually very boring. It was the World Wide Web that made it possible for pictures and sound to be displayed and exchanged over the Internet in addition to text.

Perhaps the most significant predecessor of the Web was Ted Nelson's Xanadu project, which worked on the concept of Hypertext - where you could click on a word and it would take you somewhere else. In order to click on hyperlinks, as they were called, Douglas Engelbart invented the mouse, which was to later become a very important part of personal computers.

Another important building block was the URL or Uniform Resource Locator. This allowed you a further option to find your way around the Internet by entering the name of a site. Every site on the worldwide web has a unique name (such as www.nethistory.info), and this name is part of the URL (such as http://www.nethistory.info).

The other feature was Hypertext Markup Language (HTML), the language that allowed pages to display different fonts and sizes, pictures, colours etc. Before HTML, there was no such standard, and the GUIs we talked about before only belonged to different computers or different computer software. They could not be networked.

It was Tim Berners-Lee who brought this all together and created the World Wide Web. The first trials of the World Wide Web were at the CERN laboratories (one of Europe's largest research laboratories) in Switzerland in December 1990. By 1991 browser and web server software was available, and by 1992 a few preliminary sites existed in places like University of Illinois, where Mark Andreesen became involved. By the end of 1992, there were about 26 sites.

Page 2 Text:
The first browser which became popularly available to take advantage of this was Mosaic, in 1993. Also in 1993, on April 30 CERN's directors made a statement that was a true milestone in Internet history. On this day, they declared that WWW technology would be freely usable by anyone, with no fees being payable to CERN. This decision - much in line with the decisions of the earlier Internet pioneers to make their products freely available - was a visionary and important one.

In that same year Marc Andreesen founded Netscape Corporation, and the World Wide Web Consortium, which administers development of Word Wide Web standards, was formed by Tim Berners-Lee.

Then we really started to see growth. By the end of 1994 there were a million browser copies in use - rapid growth indeed!! Every year from 1994 to 2000, the Internet saw massive growth, the like of which had not been seen with any preceding technology. The Internet era had begun.

The first search engines began to appear in the mid 1990s. In the early days, the web was used mainly for simply displaying information. Interactive activities, such as on line shopping, and on line purchase of goods, came a little bit later. The first large commercial site was Amazon.com, a company which in its initial days concentrated solely on book markets. The Amazon.com concept was developed in 1994, a year in which some people claim the world wide web grew by an astonishing 2300 percent!

By 1998 there were 750,000 commercial sites on the world wide web, and we were beginning to see how the Internet would bring about significant changes to existing industries.

Section 7

Title: Early Community-based Networks

Page 1 Text:
At the same time as the academic and research communities were creating a network for scientific purposes, a lot of parallel activity was going on elsewhere building computer networks as well. This was still several years before the development of the World Wide Web.

Lee Felsenstein of the Homebrew Computer Club had begun experimenting with using computers as a communication system before the development of the PC, with his Community Memory project in the late 1970s. This system had dumb terminals all connected to one single, large computer. These dumb terminals were placed in places like laundromats, the Whole Earth Access store, and community centres in San Francisco. This network used permanent links over a small geographical area rather than telephone lines and modems. The first public bulletin board using personal computers and modems was written by Ward Christensen and Randy Seuss in Chicago in 1978 for the early amateur computers.

It was about 1984 that the first bulletin boards using PC operating systems (mainly MS DOS and Apple) began to be used. The most popular of these was FidoNet. At that time the Internet technologies were not available on PCs. Special software starting coming out (such as Tim Pozar's ufgate) to connect the Internet and Fidonet worlds.

Community networks based on Fidonet and similar technologies were becoming popular, such as PEN (Public Electronic Network) in Santa Monica, the WELL (Whole Earth 'Lectronic Link) in San Francisco, Big Sky Telegraph, and a host of small businesses with online universities, community bulletin boards, artists networks, seniors clubs, etc.

Gradually, as the 1980s came to a close, these networks also began adopting the TCP/IP standard and connecting to the Internet. Now the PC networks and the academic networks were joined, and a platform was available for rapid global development.

Page 2 Text:
By 1989 many of the new community networks had joined the Electronic Networkers Association, which preceded the Internet Society as the association for network builders. New large players such as America On Line (AOL) were also starting to make their presence felt, and a more commercial future was becoming obvious.

PEN (The Public Electronic Network) in Santa Monica, started in February 1989, may be able to claim the mantle of being the first local government based network of any size. Run by the local council, and conceived as a means for citizens to keep in touch with local government, its services included forms, access to the library catalogue, city and council information, and free email.

Meanwhile, back in the academic and research world, there were many non-military people who wanted to use the growing network but could not because of military control of Arpanet. CSNet (Computer Science Network) was formed, and as other academics who weren't computer scientists began to show interest CSNet become known as the Computer and Science Network, and through funding by the National Science Foundation eventually became NSF Network. By the mid-1980s, Arpanet was phased out, and penetration of Internet in academic circles started to become significant by the eary 1990's.

The NSFnet was to become the U.S. backbone for the global network known as the Internet, and a driving force in its early establishment. By 1989 ARPANet had disappeared, but the Information Superhighway was just around the corner.

Section 8

Title: The Development of Global Networks

Page 1 Text:
Fidonet, the first large network to connect personal computers, was established in 1983. By 1990 there were 2500 hosts all over the world, although mainly in western countries.

Community networks were beginning to spring up everywhere. By 1991 Japan had the Watarese Area Network., and Australia had the Ipswich Global Links Network from 1994. These local government based networks were often seen as a catalyst for economic development - lots of areas around the world wanted to be the next Silicon Valley.

FreeNets were another model, with the most prominent being in Ottawa Canada and Cleveland Ohio. These provided free access, and were was paid for usually by local governments wanting to get information out to the general public. FreeNets played a large role in online community building.

In addition to these more geographically centered activities, global communities of interest (later to become known as virtual communities) were starting to evolve. One such network, and a major player in the early growth of the Internet, was the Association for Progressive Communications (or APC). Formed by the joining of PeaceNet and Econet in San Francisco with GreenNet in the UK in 1987, by 1989 the fledgling association had seven foundation countries providing major hubs.

These connected to other countries with less established facilities, and through association with similar bodies such as Interdoc, and Poptel in the UK, many contacts and connections were coming on board. It was seen that by creating low cost host computers for social movements in various countries, the network could spread quickly to a lot of non profit and activist groups who might otherwise not be able to afford to communicate.

Page 2 Text:
Meanwhile the Cold War was breaking down. By 1992 the US Government changed legislation to allow the export of computer chips and software to the USSR. This provided Russian citizens the inexpensive tools they needed to connect to the emerging global communications networks. Very quickly Glasnet sprung up in the USSR, with satellite networks in many eastern European countries.

The Russian coup de tat of 1991 became a fascinating global event, with eyewitness accounts of The tanks are coming, the tanks are coming on the Internet from independent reporters on the scene. The Internet became part of the Russian people's struggle.

By the end of 1992 close to 100 countries were connected to activist networks. Major Internet hubs fed information to smaller systems using Fidonet technologies in smaller countries. The United Nations Development Program and APC members assisted the development of networks for smaller countries and regions around the world.

To increase access to these communication networks, a number of government and charity sponsored initiatives began. HandsNet in the USA looked to address poverty issues, and SeniorNet encouraged access for senior citizens. Australia's Community Information Network looked to provide access for people on low incomes. Most of these experiments became subsumed as the net grew, but they provided important roles in understanding the implications of access to or lack of access to the net.

Thus, even as early as 1994, there were significant forums arguing the case for universal access, and for access to the powerful information and communication features of the Internet to be regarded as a basic human right. In an age where a powerful communications media existed, the argument went, lack of access was denial of a fundamental human right - the right to communicate.

Section 9

Title: The Dotcom Bubble

Page 1 Text:
The dot com bubble started without the World Wide Web, and in the beginning it didn't even recognize the Internet as important. Once Al Gore began talking about the information superhighway in the early 1990s, however, Hollywood, Silicon Valley, telecommunications carriers, cable companies, and media conglomerates, all began investing.

Between April 1992 and July 1993 all of the major US business magazines had published major features on new communications and the Information Superhighway. However, these articles rarely mentioned the Internet. They were more interested in interactive television.

California Business magazine in April 1992 had Silicon Valley meeting Hollywood in a 100 billion market as its cover story. And Forbes Magazine on April 13 1992 featured cable companies beating the phone companies to wire homes for the digital age. They also touted the ultimate convergence device, where the television telephone and computer would merge in to a single intelligent box - a telecomputer.

Business Week's July 12 1993 edition had a cover story Media Mania… digital - interactive - multimedia - the rush is on. Time Warner's Gerard Levin talked of switching home televisions to anything, anywhere. Electronic books and magazines were about to change the world. Interactive TV would get to 20% of US homes by the turn of the century.

This helps us to realize that the Internet didn't catalyse the dot com bubble. It was merely latched on to as a vehicle when other avenues for investment did not appear to be going anywhere. The bubble was the second California Gold Rush and digital convergence before it became dot com.

Page 2 Text:
Prior to 1994, telecommunications companies were mainly interested in producing smarter phones, which would be like computers. It probably took another 10 years before we started to see the sort of developments they envisaged appearing in the mobile phone arena.

TV and cable companies predicted interactive television with 500 channels plus, interactivity, and video on demand. Even Microsoft thought this was likely to be the main game, and Microsoft turned up at cable shows touting new navigation screens for the about-to-be 500 channel television set. TV, however, looks much the same now as it did 10 years ago.

The non-networked personal computer also looks much the same as it did a decade ago. The last great advances in standalone computing were the mouse and GUI. Speed for common tasks (such as opening a word processor) does not appear to be any faster, although some added functionality is available.

The networked computer however stands as the phenomena which has most affected our lives and caused changes. The shift of the computer from a computational to a communicating device, connected to the global Internet, is perhaps the most significant change of the information technology age so far.

Not since the South Sea Island bubble in the 1700s had western economies experienced anything like the dot com economic bubble. Suddenly everyone wanted a piece of the action. But almost overnight it disappeared during 2000 and 2001. The information age prophets of great things to come disappeared along with the monetary profits, and we all began to adjust to a more normal life, albeit one greatly enhanced by the large scale adoption of the Internet in western countries.

Section 10

Title: The History of the Internet Protocols

Page 1 Text:
The Internet base protocols and systems were mainly devised in the 1970s and 1980s. Many were established initially as a means to connect mainframe computer systems for timesharing purposes. Parts of the system are now over 20 years old, and the Internet is required to perform a number of important functions not included in the original design.

And we should start with the mother of all systems, the world's largest database, the Domain Name System or DNS. Each host on the Internet has a range of IP (or Internet protocol) numbers. The Domain Name System maps the numbers to names of hosts or websites (e.g. www.google.com, www.hotmail.com). Thus, when a user enters a name, the Internet knows which number to send the query to by looking up the host name in the DNS database. The DNS was introduced in 1984, several years before commercial traffic was able to be part of the Internet.

Associated with the DNS is the WHOIS database, which stores details of the names and addresses of domain owners and technical contacts. In the early days, there were no privacy issues or privacy laws to think about. However that's changed, and some problems associated with the current system include the ease with which contact details could be used for spam mailing lists, and the nuisance domain name renewal business which exploits the openness of the database.

Also, DNS in its current state is proving unsuitable for multilingual domain names. Now as the Internet spreads, the 80% of people on Planet Earth who don't use English as their primary language want to use the Internet to communicate. It currently works well for some similar European languages, but when we start to use Japanese and Arabic character sets, for instance, a whole lot of problems emerge.

Page 2 Text:
This is because the DNS uses a system called ASCII, or the American Standard Code for Information Interchange. ASCII doesn't accommodate these other languages well, thus one of today's current internet problems emerges.

SMTP, or the Simple Message Transfer Protocol, is the basic standard for email, and again exists since the 1980s when the Internet was small. SMTP comes from an innocent age, and no one thought it would be necessary to prove that the person sending a message was who they said they were. The basic flaws in SMTP authentication allow spam, and makes Internet fraud through phishing scams a lot easier than it might otherwise be.

Another important protocol which dates from pre 1972 is FTP, or the File Transfer Protocol. This simply is the way to upload or download a file from an Internet computer.

Just about everyone who owns a website uses this one.

With the coming of the World Wide Web, we see another powerful protocol - http, or hypertext transfer protocol. HTTP allows us to click on the name of a site and visit it. Simple, but very powerful.

The protocol on which all of the others run is TCP/IP, or Transmission Control Protocol-Internet Protocol. Invented in the 1970's, largely adopted in the late 1980s, TCP/IP hit its first big problem in the early 1990s when it became apparent that the numbering system was going to run out of numbers in the foreseeable future. Therefore in 1995, after several years of work, TCP/IP Vs 6 was released to solve this problem. Adoption has been very slow. TCP/IP has proven to be remarkably robust.

Quiz Items

Item number example: 1A indicates Section 1, Question A

1A
The author contends that humans would have inevitably developed an Internet because:

1. Some form of computers have been around a long time
2. Humans have a need to build complex machines
3. Humans have always had a deep desire to communicate over distance
4. Computers would start talking amongst themselves eventually anyway
5. Some early cave paintings depict computer-like devices

Correct answer: 3

1B
What does the author say about speech and language?

1. They are our primary and oldest communication tools
2. They are not very good for communicating over distance
3. It is difficult to know when they first developed
4. Long-distance transportation has interrupted their evolution
5. It wasn't until the Egyptians invented papyrus that written language could be translated from heiroglyphics into Roman letters.

Correct answer: 1

1C
Carrier pigeons, smoke signals, and Morse code flags were:

1. Some of our earliest methods of communicating over distance.
2. The immediate predecessors of the printing press.

3. Replaced by signal drums and trumpets in the 16th century.
4. All methods of long-distance communication used by the Japanese in World War II.
5. Used in England after the beginning of the industrial revolution.

Correct answer: 1

1D
The author states that electricity and the telegraph were:

1. Inevitable extensions of 18th century industrial research
2. Made possible by electronic broadcast technology
3. The big inventions of the 19th century
4. The building blocks for the electric typewriter and dictaphone
5. Suppressed by Pope Maximus IV for over fifty years

Correct answer: 3

1E
Marshall McLuhan, in his book Understanding Media, said that during the early stages of development a new technology is:

1. Thoroughly researched before being developed commercially
2. Embraced only by the wealthy
3. Much misunderstood
4. Hidden from public use until safe uses can be found
5. Widely used without regard for safety

Correct answer: 3

1F
What developed into the biggest single connected construction on the planet, and provides the physical infrastructure on which the Internet was built?

1. Electric power grids
2. The trans-Atlantic telephone trunk lines
3. Fiber-optic cable networks
4. Telegraph networks
5. Interstate roadways and railroads

Correct answer: 4

1G
Electronic networks began with:

1. The radio industry

2. The telephone and telegraph system
3. The television industry
4. The peer-to-peer electric printing press
5. Edison's invention of the electric light bulb

Correct answer: 2

1H
What can be said about the origins and growth of the telegraph system?

1. The first line was built in 1844; within seventeen years telegraph wires covered the USA
2. The first line was started in Washington in 1844; it was finally connected to Baltimore seventeen years later
3. Most people thought it would never work; by 1844 a telegraph could be sent from London to Paris
4. The Civil War spurred development of electronic signal technology; the first line between Atlanta and Chicago was tested in 1844
5. Samuel Morse translated smoke signals into dots and dashes; Morse code was developed in 1844

Correct answer: 1

1I
The author concludes that our primary activity as human beings is:

1. Hunting and gathering
2. Traveling long distances for game
3. Developing transportation devices
4. Communicatation
5. Building ever more elaborate dwellings

Correct answer: 4

1J
The author states that in the earliest days people thought of the telegraph system in terms of broadcasting. What does he mean by this?

1. Many people would listen at once
2. It would be used for one-way communications
3. It would be limited to entertainment, such as music
4. You would need a special broadcast reception device to hear it
5. Music and information would be broadcast in specific channels

Correct answer: 2

2A
According to the Pentagon official in charge of the Arpanet program, the original purpose of ArpaNet was:

1. Scientific
2. For use in developing military strategy
3. To provide an email system for troops overseas
4. To allow military intelligence information to survive a nuclear attack
5. None of the above

Correct answer: 1

2B
Arpanet was about:

1. sending email
2. packet switching
3. time sharing
4. allowing graphics to appear in Web pages
5. a worldwide communications network

Correct answer: 3

2C
According to the author, a good definition of the Internet is :

1. A global collection of Web pages
2. The worldwide network for sharing computer processing power
3. A global, internetworked email and Web page system
4. The internetworked computer platform originally developed to prevent a nuclear attack
5. A worldwide system of interconnected networks and computers

Correct answer: 5

2D
One of the important things Arpanet did in 1969 was to develop a variation on a technique called __________, a means by which messages can travel from point to point across a network :

1. Fiber optic transfer
2. Nuclear attack avoidance
3. Packet switching
4. Time sharing
5. backbone protocol

Correct answer: 3

2E
The author believes that the real beginning of the Internet was in 1973, when Bob Kahn and Vint Cerf met to discuss:

1. Interconnecting networks that weren't the same
2. A fiber optic connection between Stanford University and ARPANet
3. The development of the first graphical Web browser
4. Packet-switching between Stanford University and IBM's Deep Blue computer
5. Bill Gate's idea of a personal computer

Correct answer: 1

2F
According to the author, the Internet was more a product of ___________ than a product of the post-war Pentagon era.

1. Packet switching
2. University researchers and computer professionals
3. The US telecommunications industry
4. Computer time sharing at military bases
5. Institutions needing tremendous processing power for large calculations

Correct answer: 2

2G
Which of the following is the most likely origin of the word Internet:

1. The term was developed by AT&T around 1983
2. It was a shortcut for internetworking, and first used in 1974
3. It was coined by Arpanet in the early 1960's to refer to inter packetswitched networked systems
4. It was first used by American Online in an advertising brochure in the early 1990's.
5. The military's name for their first networked system - Internetwork Alpha

Correct answer: 2

2H
The basic concepts of TCP were developed in the early 1970's when Bob Kahn and Vint Cerf met at Stanford University to discuss:

1. Interconnecting identical packet networks
2. The problem of mainframe computers failing during a nuclear strike
3. The theoretical limits of electrical transmission on telephone wires

4. Interconnecting packet networks that were NOT identical
5. Computer timesharing between Stanford and Yale

Correct answer: 4

2I
Bob Taylor, the Pentagon official in charge of the Arpanet, insists that the purpose of Arpanet was:

1. to allow the US military's computer networks to survice a nuclear attack
2. to develop a technology for creating a world-wide network of computers
3. strictly limited to military communications during conventional warfare operations
4. a closely-guarded military secret
5. scientific

Correct answer: 5

2J
________ is the backbone protocol which technical people claim is the basis for determining what the Internet is.

1. TCP/IP
2. Arpanet
3. Packet switching
4. Ethernet
5. Fiber Optics

Correct answer: 1

3A
The Internet was invented by

1. the Pentagon
2. Arpanet
3. many people and many groups
4. university researchers
5. Xerox PARC

Correct answer: 3

3B
When considering when the Internet began, the one thing historians seem to agree on is:

1. the year was 1969

2. the place was the Pentagon
3. the place was Stanford University
4. the year was not 1969
5. the first important software was Internet Explorer

Correct answer: 4

3C
According to the author, packet switching:

1. was a false start in the development of the Internet.
2. was one of the historical developments that eventually lead to the Internet.
3. was never an important part of the Internet.
4. was only used by Arpanet
5. was adopted by Compuserve and AOL.

Correct answer: 2

3D
Network applications

1. provided the first examples of packet switching later implemented on the Internet
2. demonstrated the importance of TCP/IP
3. were never important until the early 70's
4. were first developed at Xerox PARC
5. provided the application models later implemented on the Internet

Correct answer: 5

3E
Important contributions to the development of the Internet as we know it today were made by Xerox PARC. Which of the following contributions did Xerox PARC make?

1. TCP/IP
2. application models such as email
3. the graphical user interface and ethernet
4. packet switching
5. technologies and infrastructure that made the development of TCP/IP possible

Correct answer: 3

3F
The author concludes that the history of the Internet is/was

1. difficult to understand
2. the history of an era
3. made possible by Compuserve and AOL
4. the history of the World Wide Web
5. analogous to the history of the electric train

Correct answer: 2

3G
Important contributions to the development of the Internet as we know it today were made by the telecommunications companies. Which of the following contributions did the telecommunications companies make?

1. TCP/IP
2. application models such as email
3. the graphical user interface and ethernet
4. packet switching
5. technologies and infrastructure that made the development of TCP/IP possible

Correct answer: 5

3H
Online services such as Compuserve, Fidonet, and Dialcom provided network applications that people used to communicate using computers. Which of the following contributions did these network applications make?

1. TCP/IP
2. application models such as email
3. the graphical user interface and ethernet
4. packet switching
5. technologies and infrastructure that made the development of TCP/IP possible

Correct answer: 2

3I
A popular belief, which the author refutes, about the beginnings of the Internet is that:

1. the Internet was originally conceived by the Pentagon as a way for computer networks to survive a nuclear attack.
2. the Internet was designed as a messaging system for the military to use during conventional warfare.
3. the Internet as we know it today is the result of many developments happening at many places.
4. Donald Davies from the UK developed the first packet-switching technology.
5. Arpanet was concerned only with application models such as email.

Correct answer: 1

3J
The author reports that in 2004 a celebration was held for the Internet's 35th birthday. The author concludes that:

1. this date is an accurate reflection of the timeline of the Internet's development.
2. it was actually the telecommunication companies that developed the Internet in the 1980's.
3. the only realistic date on which the Internet can be said to have been born was 1978, when TCP/IPv4 was released.
4. this date is refuted by many people, and not an accurate timeline of the Internet's development.
5. Bob Taylor, who was in charge of Arpanet during the Internet's birth, agrees that this timeline is accurate.

Correct answer: 4

4A
Colossus and ENIAC, the precursors of today's computers, were developed by the UK and US governments during:

1. The Vietnam War
2. World War II
3. The Cold War
4. The Apollo missions
5. the early days of radio

Correct answer: 2

4B
In the 1950's, the US Air Force was using early:

1. modems
2. routers
3. versions of the mouse
4. color monitors
5. personal computers

Correct answer: 1

4C
By today's standards, the computers used by Arpanet and the early research networks were:

1. extremely powerful and extremely large

2. used mostly for guiding space missions
3. easy to program and use
4. monsters with very little power
5. small and not very powerful

Correct answer: 4

4D
The primary purpose of a modem is to enable:

1. Digital signals to be sent over analog telephone lines
2. Analog signals to be sent over digital telephone lines
3. Text messages but not pictures
4. A mainframe computer to connect to a printer in another building
5. Two computers to exchange data over a digital voice line

Correct answer: 1

4E
Why was Ethernet important?

1. It allowed telephone lines to support modem traffic
2. It made it possible for modems to communicate with mainframes
3. It made packet switching and Internet protocols available to computers on cabled networks (computers that were wired together)
4. It was the glue that allowed modems to communicated with telephone networks
5. It was included in MS-DOS, and launched Bill Gates and Microsoft

Correct answer: 3

4F
By the mid 1980's everthing was in place for an explosion of:

1. internetworking
2. modem sales
3. MS-DOS
4. mainframe computer networks
5. broadband systems

Correct answer: 1

4G
The author believes that although the trend currently is wireless networks and broadband systems, it was _____________ that began the age of internetworking.

1. MS-DOS networks
2. modems
3. Ethernet
4. LANs
5. packet switching

Correct answer: 2

4H
The popularity of personal computers such as the IBM PC was clearly an important factor in the growth of the Internet. However, it was the development of _________ and _________ that allowed personal computers to become communication devices.

1. MS-DOS and AppleDOS
2. The Altair 8800 and Apple 2
3. Arpanet and cabled networks
4. Microsoft and 3-Com
5. the modem and Ethernet

Correct answer: 5

4I
The author states that in comparison to the computers used by Arpanet and the early research networks, the personal computer:

1. isn't very powerful, but is much smaller
2. made the Internet accessible to everyone
3. is not as powerful, but is much less expensive
4. is much more difficult to use
5. has signficantly fewer integrated circuits

Correct answer: 2

4J
Which of the following statements most accurately represents the increase in modem speeds between the 1960's and the 1990's?

1. Modem speeds increased dramatically, with later modems many times faster than earlier modems
2. Modem speeds increased moderately, with later modems about two to three times as fast as earlier modems
3. Modem speeds didn't increase by much, but the distance of transmission increased greatly
4. Modem speeds have increased slightly, but the prices have fallen dramatically

5. The introduction of MS-DOS allowed modem speeds to reach their highest levels

Correct answer: 1

1. 5A
2. Which of the following statements is most accurate in regard to the development of email:
3. It evolved from simple beginnings, and is older than the Internet.
4. It was invented by Arpanet in the 1960's.
5. It was developed by the Internet Task Force as a way of sending messages between users.
6. It was developed so that ordinary Web users could send messages to each other.
7. Microsoft Outlook made email possible over the World Wide Web.

Correct answer: 1

5B
Of the following email systems used on mainframe computers, which one was the first to be used?

1. SendMail
2. MessageCommand
3. MAILBOX
4. SMTP
5. POP3

Correct answer: 3

5C
Which of the following statements is most accurate regarding the development of email?

1. The earliest email systems would allow text messages to be sent from one computer to another, but not pictures.
2. The earliest email systems were used to send messages between users on a single mainframe computer.
3. Hotmail, Yahoo! mail, etc. became popular so quickly that developers didn't have time to build in anti-spam mechanisms.
4. Email was developed for the military by Arpanet in the 1960's.
5. Microsoft Outlook was the first computer application to feature email.

Correct answer: 2

5D
The use of the @ symbol to identify a user at a computer was :

1. developed by Ray Tomlinson, an Arpanet contractor, in 1972
2. first used on the World Wide Web in 1994
3. not a requirement until the mid-90's
4. first implemented in the MAILBOX application on mainframes
5. first used in Microsoft Outlook

Correct answer: 1

5E
The first important email standard, which is still in use, was:

1. MAILBOX
2. Microsoft Outlook
3. Text wrapping standard, or TWS
4. Simple message transfer protocol, or SMTP
5. USENET

Correct answer: 4

5F
One of the first email developments when personal computers came on the scene allowed email users to store messages on their own personal computers. These were called:

1. message assistants
2. offline readers
3. message stores
4. email browsers
5. message box folders

Correct answer: 2

5G
The author states that the simple message transfer protocol, or SMTP, is still in use today, but has an unresolved problem. Which of the following statements is most accurate in regard to this problem?

1. It doesn't use current addressing schemes, so messages can get lost.
2. It's slow compared to other programs such as Microsoft Outlook.
3. It is not compatible with Hotmail, Yahoo! Mail, and many other popular systems.
4. It makes no attempt to find out whether the sender of a message is who they purport to be.
5. It requires a per-minute charge to use.

Correct answer: 4

5H
Which of the following statements is most accurate regarding the use of email at Arpanet?

1. It was developed at Arpanet in the 1960's.
2. It's use was forbidden at Arpanet because of spam concerns.
3. Arpanet was the first government agency to purchase a commercial email package.
4. It was the popularity of email at Arpanet that caused Microsoft to launch Outlook.
5. It became the saviour of Arpanet, and caused a radical shift in Arpanet's purpose.

Correct answer: 5

5I
Once computers began talking to each other over networks, it was necessary to:

1. have users select unique usernames and passwords.
2. develop an addressing system, much like a postal letter, that would allow a message to go from one user to another user on a different network.
3. develop a communication mechanism that would allow messages to travel from one computer to another over a network.
4. install either the MAILBOX or SNDMSG programs on each computer that was to be email capable.
5. install Microsoft Outlook on each computer that was to be email capable.

Correct answer: 2

5J
The author states that the simple message transfer protocol, or SMTP, is still in use today, but has an unresolved problem. According to the author, this problem has led to:

1. incompatibilities between older systems and newer systems.
2. problems with security frauds and spam.
3. large attached file sizes slowing down the network.
4. many messages getting lost on the way to their destination.
5. poor communication between mainframe computers and personal computers.

Correct answer: 2

6A
The World Wide Web brought what important advancement to the Internet?

1. Made the information available more visually appealing by combining text and graphics
2. Allowed for searching huge databases, such as the Library of Congress
3. Provided a heirarchical menu approach for navigating information

4. Allowed for exchange of large amounts of information
5. Made email addresses available to anyone

Correct answer: 1

6B
The important contribution made by Ted Nelson's Xanadu project to the development of the World Wide Web was:

1. The development of Web-based email
2. The first implementation of a graphical user interface (GUI) for the Web
3. It developed into CompuServe
4. It's implementation of hypertext and hyperlinks
5. The development of Web Fisher, which later became Internet Explorer

Correct answer: 4

6C
Before Hypertext Markup Language (HTML), the only industry standard for Web-based graphical user interfaces (GUI's):

1. was TML (Text Markup Language).
2. used Uniform Resource Locators (URL).
3. was Centered Electronic Resource Networks (CERN).
4. had not yet been developed.
5. used non-standard file types.

Correct answer: 4

6D
Where were the first trial implementations of the World Wide Web conducted?

1. The University of Chicago
2. CERN labs in Switzerland, one of Europe's largest research laboratories
3. The World Wide Web Consortium at MIT
4. Simultaneously in the US, Germany, and Switzerland
5. Ted Nelson's Xanadu project

Correct answer: 2

6E
According to the author, one of the most visionary decisions by CERN was:

1. to make modems freely available to colleges and universities

2. to make Web technology freely available
3. to create Amazon.com.com as an online book store
4. the founding of Netscape Corporation in 1994
5. the creation of the World Wide Web consortium at the University of Illinois

Correct answer: 2

6F
The first large commercial Web site was:

1. Google
2. Ted Nelson's Xanadu project
3. Amazon.com
4. Hotmail
5. Arpanet

Correct answer: 3

6G
Which of the following statements is most accurate regarding the growth of the World Wide Web:

1. There were about 26 Web sites at the end of 1992, and 750,000 commercial sites by 1998.
2. The World Wide Web grew slowly between the 1970's and the 1990's, when its growth exploded.
3. The World Wide Web grew at a steady and rapid pace between 1985 and 1998, when its growth exploded.
4. The World Wide Web was used only by Arpanet for most of its history, until CERN made it public in 1992.
5. The growth of the World Wide Web was fueled by the development of search engines in the early 1990's.

Correct answer: 1

6H
An important building block of the Web was the URL, or Uniform Resource Locator. The URL allows you to:

1. post Web pages to a Web site.
2. download and install the browser of your choice.
3. surf the Web without paying a fee to each site you visit.
4. see both pictures and text in your Web browser.
5. find your way around the Internet by entering the name of a site.

Correct answer: 5

6I
Which of the following statements is most accurate concerning the role of CERN (one of Europe's largest research laboratories) in the history of the World Wide Web?

1. CERN was where hypertext and hyperlinks were developed, along with the mouse.
2. The first trials of the World Wide Web were conducted at CERN, and CERN made Web technology freely available to everyone.
3. CERN developed both the technology and business strategy behind Amazon.com.
4. CERN developed the first Web search engine.
5. Netscape Corporation was founded at CERN by Tim Berners-Lee.

Correct answer: 2

6J
Which of the following statements is most accurate regarding the growth of commercial Web sites such as Amazon.com?

1. At first the Web was used for simply displaying information, interactive features such as on-line shopping came a little later.
2. Although a few online shopping sites existed as early as 1991, it wasn't until consumer credit laws allowed Web-based credit card transactions that commercial sites such as Amazon.com really took off.
3. The mission of CERN was from the beginning the creation of global e-commerce, based on the belief that commerce is the best way to maintain peace and cooperation between nations.
4. Amazon.com was originally launched as an online retailer of DVDs and CDs. With the success of mp3 download sites such as Napster, Amazon.com moved into book sales, then added other merchandise.
5. Commercial Web sites were the first to use hyperlinks and graphic images on the same page.

Correct answer: 1

7A
When considering the development of PC and community networking, which of the following statements is most accurate:

1. It was the widespread appeal of the World Wide Web that led to the development of PC and community networks.
2. PC and community networks developed in parallel to the Internet.
3. Corporations such as IBM and Apple were the first to develop working networks of personal computers.

4. The Public Electronic Network in Santa Monica attached the first dumb terminal to the World Wide Web.
5. It was the creation of HomelessNet in New York that launched community networking.

Correct answer: 2

7B
Lee Felsentein of the Homebrew Computer Club began networking computers before the development of the PC by:

1. connecting several computers in Santa Monica with permanent links rather than phone lines.
2. connecting public bulletin board systems in Chicago and San Francisco
3. connecting UNIX and MSDOS based computer systems via simple telephone connections
4. placing dumb terminals in laundromats and community centers, all connected with permanent links to one single, large computer.
5. connecting MSDOS and Apple computers together with permanent connections over a small geographical area.

Correct answer: 4

7C
Before Internet technologies were available for the PC, among the most popular public bulletin board systems written for the personal computer was:

1. Dogbert
2. Homebrew Computer Club
3. Computer Science Network
4. FidoNet
5. UNIX

Correct answer: 4

7D
According to the author, the first local government-based network of any size designed to keep citizens in touch with local government was:

1. Computer Science Network (CSNet) in Washington
2. National Science Foundation Network (NSFNet) in Boston
3. The Public Electronic Network (PEN) in Santa Monica
4. Electronic Networkers Association (ENA) in Los Angeles
5. Americal Online (AOL) in the US

Correct answer: 3

7E
Scientists at universities without military connections received funding from the National Science Foundation to form:

1. Computer Science Network (CSNet)
2. Non-military Arpanet (NMArpa)
3. The Community Memory Project
4. The Homebrew Computer Club
5. Americal Online (AOL)

Correct answer: 1

7F
What major contibutor to the early development of the Internet was phased out and had finally disappeared by 1989?

1. NSFNet
2. The Public Electronic Network (PEN)
3. CERN
4. Arpanet
5. The Homebrew Computer Club

Correct answer: 4

7G
Which of the following statements is most accurate regarding the growth of community networks?

1. Community networks developed before Internet technologies were available for personal computers, and helped drive demand for Internet technologies for PCs once these technologies became available.
2. Community networks were made possible by large commercial services such as America On Line.
3. Community networks were an early experiment with free Internet service, but they were quickly taken over by commercial Web sites.
4. Arpanet allowed non-military use of its network in the mid-1980's, and community networks began to emerge.
5. Large commercial services such as America On Line were well established before the first community networks came online.

Correct answer: 1

7H

According to the author, a platform was made available for rapid global development when:

1. Arpanet was merged into the Information Superhighway.
2. community networks began adopting the TCP/IP standard and connecting to the Internet, thus joining the academic networks.
3. CSNet was connected to Arpanet, thus joining military and non-military academic researchers together to form the Internet.
4. local governments began adopting technologies such as Fidonet, and joining Arpanet.
5. non-computer scientists began to show interest in joining Arpanet.

Correct answer: 2

7I
Which of the following statements is most accurate regarding the use of dumb terminals connected to a single, large computer?

1. Such systems are used today to communicate in moving spaces such as airplanes and cruise ships.
2. These systems were replaced at Arpanet in the late 1980's, effectively transforming Arpanet into CSNet.
3. Such systems were used before the advent of PCs to set up communication networks such as the Community Memory Project ,which placed terminals in easily-accessible places like laundromats.
4. Such systems required TCP/IP to transfer data, and thus became the very first internetworked communication systems.
5. These were the first computers outside of Arpanet to use TCP/IP for establishing community networks.

Correct answer: 3

7J
According to the author, PEN (Public Electronic Network) in Santa Monica, the WELL (Whole Earth 'Lectronic Link) in San Francisco, and Big Sky Telegraph are all examples of:

1. non-military academic projects funded by NSFNet.
2. spin-offs of Arpanet when it was phased out in 1989.
3. early Web sites that used dumb terminals.
4. the first non-military networks to use TCP/IP.
5. community networks based on Fidonet and similar technologies.

Correct answer: 5

8A
FidoNet, the first large network to connect personal computers, was established in 1983. By 1990 it had grown to include how many hosts around the world?

1. Less than 500.
2. Nearly as many as Arpanet.
3. 2500, although mostly in western countries.
4. Between 7000 and 8000, with a largest concentration in Japan and South Korea.
5. Well over 10,000, spread all over the globe.

Correct answer: 3

8B
Which public network model featured free network access, usally paid for by local governments, and played a large role in online community building?

1. Glasnost
2. Arpanet
3. the Association for Progressive Communications
4. Australia's Community Information Network.
5. FreeNets

Correct answer: 5

8C
One of the primary drivers of the early global spread of PC networks was:

1. Global commercial interests
2. International cooperation among social and environmental activists
3. International cooperation among American and European military branches
4. The desire for Web access for US soldiers overseas
5. Hobbyists in the US, Great Britain, and Australia

Correct answer: 2

8D
Computer networking in the USSR and eastern Europe was helped in 1992 by:

1. The legalization of computer chip and software exports to the USSR by the US.
2. The fall of the Berlin Wall and the roadways that opened up allowing for computer goods to enter East Germany.
3. The legalization of computer chip and software imports by the USSR from the US.
4. The decline of Russian satellite networks which prevented Internet communication.
5. The end of Glasnet and the opening of the Russian Internet.

Correct answer: 1

8E
In addition to international communcation between academic and research organizations, what other type of organizations had established global network communications in close to 100 countries?

1. Military
2. Retail supply/international wholesalers
3. Political and social activist
4. Religious
5. Banking

Correct answer: 3

8F
A concern that began to arise as early as 1994 was:

1. The lack of security for online financial transactions.
2. Phishing and spy-ware scams.
3. Spam email.
4. The spread of pornography and violence on the Web.
5. Lack of universal access to the Internet.

Correct answer: 5

8G
According to the author, which of the following statements is most accurate in regard to the historical case for universal access to the Internet?

1. Universal access never became a real concern until the importance of the Internet in education became clear.
2. Many groups began making the case as early as 1994 that lack of access to the Internet was a denial of a basic human right - the right to communicate.
3. Univeral access to the Internet was a party platform issue of the British Labour party in 1992, the first time the issue was introduced into politics.
4. The debate has centered largely around fears that univeral access to the Internet would be abused by email spammers and pornographic Web sites.
5. The issue died down in the late 1990's when govenment officials realized that computers could be made available in public libraries.

Correct answer: 2

8H

According to the author, the Internet became part of the Russian people's struggle during the:

1. Bolshevik revolution.
2. Cold War.
3. collapse of the Berlin Wall.
4. Russian coup de tat of 1991.
5. fall of Czar Nicholas II.

Correct answer: 4

8I
According to the author, which of the following statements is most accurate concerning the development of global communities of interest (later to become known as virtual communities)?

1. A major player in the early growth of the Internet, the Association for Progressive Communications (APC) was formed by the joining of PeaceNet and Econet in San Francisco with GreenNet in the UK.
2. Australia's Community Information Network set the stage for rapid deployment of the Internet in rural areas.
3. Ipswich Global Links Network demonstrated the ability of virtual communities to reach out to inhabitants of rural areas.
4. Virtual communities allowed affinity groups to form - this had the effect of highlighting the need for universal access.
5. It was AOL that developed the first Web-based message board.

Correct answer: 1

8J
According to the author, which of the following statements is most accurate regarding the impact of the US government's decision to allow the export of computer chips and software to the USSR?

1. It forced Russian computer manufacturers out of business, and ensured US domination of the Russian market.
2. It provided Russian citizens the inexpensive tools they needed to connect to the emerging global communications networks.
3. It demonstrated the effectiveness of global charity initiatives.
4. At first the former Soviet Block nations of eastern Europe were outraged, but soon understood the need for universal access.
5. It led almost overnight to the collapse of the Berlin Wall and the fall of communism.

Correct answer: 2

9A
The dotcom bubble started with speculation in US business magazines about the converged world of Silicon Valley and Hollywood in:

1. the Internet.
2. interactive television.
3. CD-ROMS.
4. extremely realistic video games.
5. Web-based shopping carts.

Correct answer: 2

9B
According to the author, which of the following statements is most accurate regarding the dot com bubble:

1. The problems started when online stockbrokers such as ETrade became a reality.
2. Real estate speculators discovered it, and it exploded.
3. It started without the World Wide Web.
4. It ended once Hollywood producers saw that movie DVDs could be pirated .
5. US business magazines ignored the World Wide Web until Amazon.com proved that interactive television was profitable.

Correct answer: 3

9C
The author notes the following about TV:

1. It's been medium of choice for the last 50 years.
2. It's the 500 channel predecessor of the Web.
3. It's the couch potato of the digital age.
4. It looks much the same now as it did 10 years ago.
5. It is the greatest potential convergence device.

Correct answer: 4

9D
The last greatest advances in standalone computing:

1. were the modem and the network adapter.
2. have yet to be developed.
3. were the mouse and the GUI.
4. were improved speed and reliability.
5. have come in the last five years.

Correct answer: 3

9E
The most significant change of the information technology age thus far is:

1. the shift of the computer from a computational device to a communication device.
2. the development of the World Wide Web.
3. the development of inexpensive computer network systems.
4. the proliferation of email into nearly every home.
5. not yet known.

Correct answer: 1

9F
According to the author, what happened to the financial action of the dot com bubble?:

1. It was destroyed by stronger laws regulating stock trading.
2. It was taken over by Hollywood and media interests .
3. US government regulations eventually crippled it.
4. Almost overnight it disappeared.
5. It slowly fizzled.

Correct answer: 4

9G
According to the author, the most signficant change of information technology so far is:

1. The shift of the computer from a computational device to a communicating device.
2. The ability to view Web sites from a home computer.
3. The digital gold rush.
4. The graphical user interface, which allowed people to navigate information by clicking on hyperlinks.
5. The shift of the computer from a computational device used for business purposes to an entertainment device in the home.
6. The advent of interactive television.

Correct answer: 1

9H
According to the author, which of the following statements is true concerning the mouse and the GUI?:

1. The dot com bubble began when the mouse and the GUI become popular.
2. They were the last great advances in standalone computing.

3. They haven't changed much over the last 20 years.
4. The mainframe computers on which they were invented were not able to make the shift to networking.
5. They were touted by California Business magazine as an enabling technology - this led to the dot com bubble.

Correct answer: 2

9I
According to the author, what can be said about non-networked personal computers?

1. They have changed radically over the last 10 years due to public pressure.
2. The dot com bubble would not have happened without the development of inexpensive DVD drives.
3. They look much the same as they did a decade ago.
4. Silicon Valley and Hollywood pressured the computer manufacturers to made radical changes to them over the past decade.
5. The most signficant change is the ability to play sound and video files.

Correct answer: 3

9J
In the early 1990's all of the major US business magazines had published major features on the Information Superhighway. According to the author, however, these articles rarely mentioned:

1. The importance of the mouse and GUI.
2. The contributions of Arpanet.
3. Interactive television.
4. The Internet.
5. The significant improvements in network technologies.

Correct answer: 4

10A
Many of the Internet base protocols were devised initially for the purpose of:

1. streaming real-time audio and video.
2. connect mainframe computers for time sharing
3. allow efficient transfer of HTML
4. taking over for the phasing out of Arpanet
5. to enable Web pages to display graphical content

Correct answer: 2

10B
What does the author refer to as the mother of all systems and the world's largest database?:

1. Arpanet.
2. TCP/IP.
3. the Simple Message Transfer Protocol, or SMTP.
4. The Domain Name System, or DNS.
5. the World Wide Web.

Correct answer: 4

10C
DNS is proving unsuitable for:

1. multilingual domain names.
2. the number of new domain name registrations.
3. fast host name resolution.
4. transferring large files.
5. preventing spam and phishing scams.

Correct answer: 1

10D
The WHOIS database is associated with DNS and is used to:

1. prevent spam and phishing scams.
2. store the name and address details of domain name owners.
3. send email between domain names.
4. route messages between Web sites.
5. translate non-English domain names.

Correct answer: 2

10E
What is FTP used for?

1. To upload or download files from an Internet computer
2. To view Internet Explorer files in Netscape Navigator
3. To add numbers to the TCP/IP system
4. To send email messages between Web sites
5. To allow DNS to resolve non-English domain names

Correct answer: 1

10F
When was TCP/IP largely adopted?

1. After the World Wide Web became popular
2. Once it became clear the SMTP couldn't prevent spam and phishing scams
3. In the early 1970's
4. When Arpanet made it their official protocol
5. In the late 1980's

Correct answer: 5

10G
What does DNS do?

1. Allows for files to be uploaded and downloaded to Web sites.
2. Sends messages between Internet computers.
3. Translates non-English domain names into a usable format.
4. Maps IP numbers to names of hosts or Web sites.
5. Provides the basic protocol on which all of the others are run.

Correct answer: 4

10H
Which of the following statements is most accurate concerning SMTP?

1. SMTP is used to upload and download file to Internet computers.
2. It comes from an innocent age, when no one thought it would be neccessary to prove that the person sending a message was who they said they were.
3. Once adopted by everyone, it will greatly reduce (but not eliminate) email fraud.
4. It allows for Web pages to be displayed using HTML.
5. It provides the basic protocol on which all of the others are run.

Correct answer: 2

10I
Which of the following statements is most accurate regarding ASCII?

1. DNS uses it, but it doesn't accomodate languages well that aren't similar to English.
2. FTP relies on it, but it only accommodates English and Japanese.
3. It was designed to accommodate the languages of developed countries only, such as English, Japanese, and a couple of Arabic languages.
4. Version 3 of ASCII was designed to support SMTP.
5. ASCII is no longer used by most email programs, such as Microsoft Outlook.

Correct answer: 1

10J
According to the author, the basic flaws in SMTP authentication have allowed:

1. The limited set of TCP/IP numbers to be used unwisely.
2. Email messages to be routed to the wrong networks.
3. Spam and Internet fraud to be perpetrated more easily.
4. Email traffic to back up on major Internet routes.
5. Web sites to be hacked more easily.

Correct answer: 3

About the Author

John M. Bunch, Jr. received a Bachelor of Arts degree with a major in Psychology from the University of North Carolina at Charlotte in 1987. He received a Master of Arts degree in Psychology from Appalachian State University in 1990. He entered the PhD program in Instructional Technology at the University of South Florida in 2003, after several years of wandering the earth.