On Leveraging the First Impression:

Learning, Achievement Motivation, and the Design of Digital Tasks

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THESIS

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This thesis is dedicated to my grandmother, Marcia Hung, and in loving memory of my grandfather, Alan Hung. Thank you both for teaching me that there are few things more valuable than a good education.

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ACKNOWLEDGEMENTS (continued)

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

LIST OF TABLES

LIST OF TABLES (continued)

LIST OF TABLES (continued)

LIST OF FIGURES

SUMMARY

This research sought to gain a better understanding of the notion of the 'all important first impression' as it relates to digital learning by (1) investigating in more detail just what constitutes students' impressions of an impending educational task via the measurement of this construct and (2) examining how manipulations designed to elicit differing initial perceptions about what is essentially the same task might affect different aspects of the educational experience and how well students learn.

The first major goal of the research was addressed via the creation and development of a new scale, *Impressions of the Task*. By capturing various perceptions a student might have with respect to a computer-based, educational task's quality characteristics, the scale successfully measures a students' overall impressions regarding the task at hand while providing a means for understanding in greater detail just what constitutes the impressions students may form about a task. In addition to perceptions regarding the quality characteristics of a given task, exploratory factor analysis revealed three underlying dimensions of the *Impressions of the Task* construct: *Social Experience, Caliber,* and *Demands on the Learner*.

To address the second major goal of this research, the effects of two vehicles of first impression formation—each representing a different channel leading to the first impression effect—were investigated: (1) the aesthetic elements of computer interface design and (2) verbal (i.e., in the form of words, written or spoken) information pertaining to the educational quality of the task. They were both examined with respect to elements of the learning process with respect to that task: students' first impressions; the formation of achievement motivation with respect to expectancies and task values; achievement-related choices; and finally the quality of learning

SUMMARY (continued)

that results, in terms of surface level and deep level knowledge.

By addressing both first impression factors together within the same study, this research uncovered an interaction effect that exists between the two, yielding results that suggest some complexity with respect to just how they can affect learning. Whether the hypotheses for this study were supported depended on the website's aesthetic design. Type of knowledge (surface versus deep level) also played a role in understanding these effects. Findings demonstrate the intricacies involved regarding the influence of multiple contextual influences with respect to an educational task and how it is received.

CHAPTER 1

INTRODUCTION TO THE STUDY

"It's not what you look at that matters, it's what you see."

- Henry David Thoreau (1817-1862)
  Author, poet, and philosopher

"Art is not what you see, but what you make others see."

- Edgar Degas (1834-1917)
  Artist

Our perceptions color the way we see the world around us. A product of perception is the first impression, which can form quickly and often without consciousness (Chen & Bargh, 1999; Duckworth et al., 2002; Norman, 2004; Ortony, Norman, & Revelle, 2004; Zajonc, 1980). For example, in as little as 50 milliseconds (or 1/20th of a second) people viewing a website have likely already formed their initial impressions of it (Lindgaard et al., 2006). First impressions have also been shown to set the tone for the subsequent thoughts and behaviors people have with respect to a given situation or experience (Ferguson, Bargh, & Nayak, 2005). If we consider the notion that how we first 'see' a given situation can in turn influence what we think and do thereafter, then just how important might the first impression be each and every time a student sits down to engage with a new computer-based activity or task? How will that student interact with the program that appears on the screen? What is that person 'seeing'?

If the initial impressions students form about a computer-based instructional task play an influential role in how well those students are able to learn with it, then a better understanding of how to leverage those effects for more optimal educational experiences is in order. In the case of

stand-alone, Web- and other computer-based lessons or activities, this kind of knowledge would be particularly beneficial because these types of learning environments—which have become increasingly common in this digital age—operate without the aid of actual human guidance and therefore without the advantages that human instructors bring to learning situations. Today and into the future, students are likely to rely on stand-alone digital learning environments (e.g., educational websites, museum kiosks, mobile apps) as part of their educational enrichment and growth. Exploiting the contextual elements of these environments that contribute to students' impressions of the task would contribute to the increased effectiveness of digital learning environments as instructional tools for the countless students who may use them.

Based on past research in classroom settings, investigating the influential nature of the first impression with respect to computer-based learning environments is a logical and timely next step. Evidence of first impression effects have been found in the classroom, influencing the expectations of both students and teachers (Buck & Tiene, 1989; Gurung & Vespia, 2007; Jamieson et al., 1987; Hamermesh & Parker, 2005; Riniolo et al., 2006; Rosenthal & Jacobson, 1968; Widmeyer & Loy, 1988). In these classroom environments, expectancy effects were observed such that the impressions in question ultimately influenced student behaviors, academic performance, and attitudes. By 'expectancy,' I refer here to the notion of this term as understood in social psychology literature to mean the beliefs people have about a given person, object, or event and the accompanying expectations regarding the situation that those beliefs bring to bear (Miller & Turnbull, 1986). The most commonly studied expectancy effect is the *self-fulfilling prophesy* (Merton, 1948), where impressions about a situation—which may or may not be accurate—evoke behaviors that actually confirm those beliefs. By exploring this concept further, through a close examination of the first impression effect, this investigation assesses how

different channels leading to this phenomenon might be leveraged toward better quality

educational experiences with computer-based learning environments.

1.1   First Impression as Strategy

Making a favorable first impression is a point of concern for many in everyday life

(DuBrin, 2010; Goffman, 1959; Patzer, 2008; Tractinsky & Meyer, 1999; Turkle, 1995; Winter,

Saunders, & Hart, 2003). Goffman (1959), for example, discusses how it is in the best interest of

any individual to control the behavior of others, "especially their responsive treatment of

him…by influencing the definition of the situation which the others come to formulate" (pp. 3-

4). People partake in such efforts because of their understanding that first impressions are both

influential and inevitable, for better or for worse. When people engage in impression

management, they aim to ensure that the information about them that is made available to the

'impressionable party' will elicit the desired impression (Dubrin, 2010; Goffman, 1959).

Regularly practiced in the fields of marketing, advertising, and public relations, the strategy of

impression management has been shown to effectively influence human thought and behavior in

both real-world and virtual environments (Turkle, 1995; Winter, Saunders, & Hart, 2003). It

follows that this strategy can also be actively employed to help establish the desired impressions

in the minds of students faced with an impending computer-based learning experience.

Thus far, research in the area of impression management regarding computer-based

media has primarily focused on commercially-oriented applications. Learners, however, have

different needs, expectations, and goals than do users of activities created for the purposes of

entertainment, marketing, and business. Likewise, the objectives of educational tasks differ from

those of their commercial counterparts and are arguably more difficult to meet. One could assert

that in certain respects they expand beyond the objectives of commercial computer-based

applications. To illustrate, user satisfaction has been a major focal point of research on how

users' first impressions influence their post-activity attitudes toward commercial websites (Bai,

Law, &Wen, 2008; Lin, 2007; Lindgaard, 2003; Lindgaard, 2007; Ozok & Komlodi, 2009;

Tractinsky, 2000; Zviran, Glezer, & Avni, 2006). Satisfaction is an aspect of the user experience

that is also important to consider regarding educational applications of computer-based media.

Yet the most crucial objective for computer-based learning environments is for students to have

actually *learned,* an undertaking that commercially-oriented applications generally need not

consider when evaluating users' experiences with computer-based media. The educational

implications of first impression effects for computer-based instructional tasks are therefore in

need of further exploration.

1.2   Impression Formation and Learning

Learning is a complicated process, and a clearer understanding of how first impressions

of a computer-based task might influence the many elements that come into play as part of this

process will both contribute to the current knowledge base in this area and serve to inform

instructional design practices for computer-based learning. To illustrate this complexity and the

various elements involved, the following scenario provides a brief depiction of the learning

process as it relates to the notion of the self-fulfilling prophecy as a consequence of the first

impression:

> *A student discovers she will be learning with a computer-based*
>
> *activity. Her perceptions of the task (based on the information*
>
> *made available to her) lead her to form beliefs regarding not only*

the quality of the task itself and what it entails, but also how she as

an individual feels about engaging with the task. This includes self-

assessments of her ability to complete the task successfully. She

then begins the task, her behaviors in accordance with the

impressions she has formed (e.g., effort, level of interaction).

Outcomes from the task reflect this behavior and can be linked

back to her initial impressions of the task. These outcomes are not

limited to measures of knowledge gain; they also include the

student's post-activity attitudes toward both the topic and future

interactions with similar learning formats.

Based on the depiction above, different first impressions could induce in the student very different thoughts about the impending task, which might then extend into different resultant behaviors and educational outcomes. On one end of the spectrum of possibilities, the student might have expected the task to be of good instructional quality and even enjoyable to do. On the other end, the student might have had little confidence in the task's ability to help her learn and therefore expected that interactions with it would be a waste of her time and effort. It seems that the first impression represents a wide range of motivational possibilities that may potentially influence the path of student engagement and learning with computer-based instruction, bringing students closer to or farther from the ideal learning experience with the task in question.

Given this spectrum of possibilities, one is left to question how different kinds of first impressions may take form. Efforts toward leveraging the first impression for more optimal educational outcomes with computer-based learning environments should also involve

investigations into how those impressions come about in the first place. A more nuanced understanding of the ways in which perception influences impression formation would provide additional insight into how people think in the anticipation of learning with computer-based instruction. When dealing with the new and unfamiliar, what people perceive is limited to the information that is available to them and how that information is contextualized with respect to the given situation (Moskowitz, 2005). How do different kinds of information provided in the context of a computer-based task lead students to 'see' their upcoming experience with it as worthwhile versus worthless? Additionally, how do these expectations then translate into action and effort with respect to the characteristics of individual students?

To begin to answer these questions, the effects of two vehicles of first impression formation are investigated, each representing a different channel leading to the first impression effect: (1) the aesthetic elements of computer interface design and (2) verbal (i.e., in the form of words, written or spoken) information pertaining to the educational quality of the task. Both were chosen due to their controllability as contextual elements of the task and its presentation to potential learners. The sections that follow provide additional background information regarding each of these choices, followed by discussion of how they relate to students' motivation and achievement with respect to a given task as conceptualized by the expectancy-value theory of achievement motivation (Eccles et al., 1983; Eccles & Wigfield, 2002; Wigfield & Cambria, 2010; Wigfield & Eccles, 1992, 2000).

1.2.1   First Impressions by Way of the Aesthetic Elements of Interface Design

As first impressions go, the most salient aspect of computer-based instruction is that which appears on the screen as students commence with the instructional task: the program's

interface. Over a decade ago, Stoney and Wild (1998) made the contention that the interface design of online instruction plays a strategically important role, influencing students' reasons for engaging with the task based on their perceptions of it. Research in the area of interface design reflects this notion regarding the quality of the computer activity's contents and organization, both conceptually and on-the-screen, yielding many valuable insights addressing the effective structuring of digital information (i.e. lesson contents, task flow, functionality, cognitive load, and usability of the interface) in order to facilitate the successful processing of that information (Lin & Dwyer, 2010; Mayer, 2005; Mayer & Moreno, 2003; Moreno & Mayer, 2000, 2007; Park, 1998; Pettersson, 2004; Rieber, 1994). In contrast, I examine the effects of the *aesthetics* of visual design on computer-based instruction with respect to the computer interface. This contextual aspect of digital learning environments lies outside of the actual structure of digital information, as described above, but may also influence learners as they approach educational websites and other computer-based tasks for instructional purposes.

This research agenda aligns with what Crilly, Moultrie, and Clarkson (2004) have described as a trend in product design literature: a shift in emphasis toward aesthetics in design versus the more practical issues of safety, usability, and comfort. Akin to concepts behind Maslow's (1943) hierarchy of needs, Yalch and Brunel (1996) suggest that upon meeting the requirements of necessity, attentions have naturally turned toward other considerations for improved product performance. To illustrate, consider the work of Norman (2002, 2004), who followed his book *The Design of Everyday Things*, which discusses the importance of usability in product design and concepts behind what makes a product usable, with *Emotional Design: Why We Love (or Hate) Everyday Things*. In the latter work, Norman argues that "attractive things work better," explaining that attractive products promote a state of positive affect in their

users, which in turn has been linked with improved cognitive processing (Isen, 1993, 2001; Isen & Reeve, 2005).

Product appearance has also been shown to elicit certain perceptions with respect to the quality of the product in question. For example, Fogg et al. (2002, 2003) found that in contrast with other studies that have investigated web users' descriptions of how they evaluate the credibility of websites, which include rigorous evaluation strategies in regards to such varied elements as when the site was last updated, the inclusion of advertisements, the reputation of the company, and the expertise of the content's author, it was actually the surface elements of websites (e.g., typography, white space, image quality, color schemes) that played an overwhelmingly large role in how users actually assessed website credibility. The visual cues embedded in the aesthetic design of the website interface elicited various perceptions of professionalism from its viewers. Sites that were seen as having a more professional look were deemed more credible by users. It is findings such as this that support Fogg's (2002) discussion of 'persuasive technology,' in which he reviews how various aspects of technological design can be used as persuasive tools with respect to the product's intended users.

To gain a better understanding of how the aesthetic aspects of computer interface design can be used strategically to 'persuade' learners that their experience with the impending instructional task will be a valuable one, this investigation examines in more detail how product appearance influences the specific perceptions involved in their initial impressions of the task—as part of how first impressions can ultimately influence the educational outcomes that result from engagement with that task.

1.2.2   First Impressions by Way of Verbal Information about the Educational Quality of

the Task

It is quite possible that users of an impending computer-based activity may have already

formed their initial impressions of it—before ever laying their eyes upon the screen. First

impressions of this kind have also been shown to influence student learning. To illustrate,

students informed that a computer-based task was of high quality both significantly

outperformed and had more favorable attitudes about the instruction than students led to believe

that the same task was of questionable quality (Fries, Horz, & Haimerl, 2006). In this case,

information provided to students about the quality of the educational resource played a

significant role in shaping the impressions those students formed, which in turn influenced their

subsequent thoughts and behaviors with respect to learning with the instructional task.

These findings support the notion of the self-fulfilling prophesy and suggest that an

action as simple as providing students with a statement or two about the quality of an upcoming

computer-based instructional task can potentially exert considerable influence over the level at

which students then choose to engage and learn with it. In combination with the effects of

interface aesthetics, this research investigates the ways in which verbal (i.e., in the form of

words, written or spoken) information provided to students about the quality of a computer-based

instructional task can influence students' impressions of the task and the educational outcomes

that follow.

1.2.3   First Impressions and the Expectancy-Value Theory of Achievement Motivation

Examination of the first impression effect requires an approach that addresses the

relationships between (1) environment and thought, (2) thought and behavior, and (3) behavior

and environment. The expectancy-value perspective developed by Eccles, Wigfield, and colleagues (Eccles et al., 1983; Eccles & Wigfield, 2002; Wigfield & Cambria, 2010; Wigfield & Eccles, 1992, 2000) puts forth a comprehensive framework that successfully integrates each of these three items. This integral approach takes under consideration students' interpretations of and expectations about given situations and the way those expectations in turn influence decisions, performance, and educational outcomes. Because anticipatory thought plays such a substantial role in this theory, it is well suited for the purposes of this research study.

The most current model of expectancy-value theory (Eccles & Wigfield, 2002) depicts a comprehensive framework that captures the complexity of the person-situation interaction that occurs in the face of an impending task. It takes into account students' prior experiences, stable characteristics, and even cultural background and other social influences that may work to shape the perspectives and thoughts of individual students regarding the task in question. Based on their perceptions about the task before them (their initial impressions of the task), students will have certain expectations about the impending experience. These expectations are put forth in the theory as *expectancies* (defined in this theory as the beliefs about one's ability to succeed at the task) and *subjective task values* (the value perceived in doing the task), which influence each other and link directly to the behavior-related final component of the model as predictors of performance and achievement-related choices.

1.3   Statement of the Problem

The development of digital learning methods and their incorporation into both school and informal instruction continues to expand, providing opportunities for 21st century students to learn in ways that would not exist otherwise. A consequence of learning in this digital age,

however, is the increasing prevalence of students embarking on computer-based educational tasks without the helpful interactions and guidance that human instructors would normally provide. Resultant outcomes produced from engagement with these computer-based tasks then rely solely on the student, what that student brings to bear in a given learning situation, and the design/implementation of the task itself. Under these circumstances, it would be wise to investigate in more detail the ways in which educational computer-based activities, which are often designed for stand-alone use, may be designed and implemented for more optimal learning experiences and outcomes.

At the very beginning and common to any and every example of computer-based instruction is the student's first impression of it. Relatively little is known with respect to what extent and in what ways students' initial impressions can influence learning outcomes from interactions with educational computer-based media. Recent literature, however, has yielded findings that suggest that these are inquiries worthy of pursuit (Fries, Horz, & Haimerl, 2006; Um, 2009; Um, Song, & Plass, 2007). If first impressions are proven to be an influential force in how students learn with computer-based instruction, then the consequential effects posed by first impressions are in need of more exploration. Further, a deeper understanding of impression formation with respect to computer-based learning formats would then serve to inform instructional design practices regarding the development and implementation of computer-based educational experiences. The sections that follow provide more information about the state of research in this area, including discussion of how this research contributes to the current knowledge base.

1.3.1 Isolation of Interface Aesthetics

One goal of this investigation is to examine the effect of interface visual aesthetics in computer-based instruction, specifically its role in impression formation and the educational consequences—good or bad—that may result from the impressions that have formed. However, determining how characteristics of aesthetic design might engender more successful (or less successful) learning outcomes is in some respects a challenging endeavor, as the visual aesthetics of any given piece of computer-based media are generally enmeshed seamlessly into the overall design, entangled with other elements such as functionality and content (Manning & Lawless, 2011).

Much past work has investigated interface aesthetics either through the comparison of several non-related websites (yielding observed trends and patterns) or through the examination of specific elements of the interface, such as button placement (Hsu, 2006; Lavie & Tractinsky, 2004; Lindgaard, et al., 2006; Schenkman & Jonssons, 2000; Sutcliffe & De Angeli, 2005; Tractinsky, Katz, & Ikar, 2000; Tractinsky et al., 2006). On one hand, examining visual aesthetics by way of a broad survey of interface designs has served to uncover valuable information about the role of aesthetics in the visual appeal and interpretation of various computer-based media. On the other hand, work that has focused on particular elements of the interface has provided knowledge about various nuances of the user experience as supplied by distinct components of the interface. There is no doubt as to the usefulness of these studies, which have approached the study of interface aesthetics from both top-down and bottom-up perspectives. The question of impression formation at the level of visual aesthetics alone still exists, however.

The very nature of computer-based media and how it is designed makes controlling for

differences that are *purely visual*—and not tied to functionality or content—a somewhat inconvenient pursuit. To illustrate, Tractinsky, Katz, and Ikar (2000) compared two alternate interface designs for the same task in order to study user's perceptions of beauty in the context of a computerized system. They linked perceived beauty and satisfaction with the interface that was more usable for the given task in terms of button placement. Although the information presented in each interface was identical, it was the *functionality* of the two interfaces—with respect to how easily each allowed the user to achieve task objectives—that was at the root of the visual differences.

This investigation contributes to this knowledge base by examining first impressions with respect to different aesthetic presentations of the same computer-based lesson—*excluding differences in functionality and content*. Isolating the effect of interface visual aesthetics in this respect is achieved by holding constant the aforementioned items. The presentation of a computer-based lesson to users is manipulated with respect to *visual aesthetics only*, by way of the interface's graphic design treatment. Along with past work by the author of this thesis (Manning & Lawless, 2011) and a small-scale study conducted in preparation for the present research (Manning, Lawless, & Mayall, 2011), work by Um and colleagues (2007; 2009) is the only other example of research that has taken a comparable approach regarding this issue.

1.3.2   Preferences and Global Judgments vs. Specific Perceptions

Research pertaining to first impressions of educational computer-based media has thus far remained at a general level with respect to both judgments of preference and quality. To illustrate, work on visual aesthetics and impression formation has tended to examine the issue with respect to visual appeal or positive/negative affect (Cheon & Grant, 2009; Lindgaard, et al,

2006; Norman, 2004; Schenkman & Jonssons, 2000; Skadberg & Kimmel, 2004; Um, 2009).

Norman (2004), for example, made the argument that "attractive things work better," advocating

the notion that better-looking products elicit more positive feelings and behaviors from their

users. Um (2009) examined the role of interface design in eliciting positive affect in learners.

Past research addressing the effect of first impressions by way of verbal information from an

outside source examined learners' judgments about the given task with respect to overall quality

(Fries, Horz, & Haimerl, 2006). These aspects of the user experience are indeed important and

deserve continued exploration. First impressions, however, encapsulate more than general

preferences, feelings, and general assessments of quality (e.g., 'good' versus 'bad'). Reflecting

user thought and opinion at a 'global' level, the current knowledge base does not yet reflect the

complexity that lies beneath and beyond these aspects of impression formation.

This research investigation reaches past these more 'general' notions of visual

preferences, feelings, and assessments about the quality of the task as delimited through past

work by investigating in more detail just how first impressions may or may not "work better"

than an alternate possibility and *why*. Work by Fogg and colleagues (2003) is one example of

research that yielded more detailed insights about the impressions viewers formed based on

computer interface designs. Their work, charting viewers' perceptions of various computer-

based media, indicated that websites whose visual aesthetics conformed more closely to

established principles of good visual design were perceived as more *credible,* a useful descriptor

in terms of design considerations. In order for educators and developers of computer-based

educational media to apply research findings in the area of impression formation and computer-

based learning in an actionable and effective manner, they will need to understand the specific

perceptions and judgments students make as part of the impressions they form. To this end, the

current investigation—building on findings from a pilot study (Manning, Lawless, & Mayall, 2011)— examines whether perceptions pertaining to credibility, enjoyableness, interactivity, and other characteristics related to the quality of a given task can make a difference in how well students learn with that task.

1.3.3   Measures of Learning

In order to determine to what extent and in what ways first impressions may affect learning with computer-based media, measures of learning must be procured in conjunction with those first impressions. The amount of research in existence that addresses this need is sparse. For example, very little of the literature related to visual aesthetics also addresses learning outcomes, for the large majority of work on visual aesthetics has been within other domains, such as marketing and entertainment, whose research goals are not generally learning-oriented. The literature base that is related to impression formation by way of verbal information pertaining to educational quality, on the other hand, currently focuses on more traditional, in-class forms of instruction.

In addition to the paucity of research linking first impressions and learning outcomes in the context of digital educational environments, the findings from the few studies that do exist have been somewhat mixed. In certain cases, actual measures of learning were not obtained (Manning & Lawless, 2011; Skadberg & Kimmel, 2004; Sutcliffe & DeAngeli, 2005). Skadberg and Kimmel (2004), for instance, found that a website's perceived attractiveness was the most significant factor leading to the flow experience (Csikszentmihalyi, 1975, 1990). The experience of flow, in turn, correlated with user reports of increased knowledge. Learning outcomes in this study, however, were limited to users' *perceived* learning rather than actual learning. Cheon and

Grant's (2009) work on interface visual aesthetics did not yield any significant difference in student learning based on alternative interface designs; work by Um (2009) and findings from a pilot study preceding the present research investigation (Manning, Lawless, & Mayall, 2011), in contrast, showed that the visual aesthetics in different interface designs *did* make a difference in how well students learned. A thorough examination of the literature in the area of first impressions of computer-based instruction by way of verbal information pertaining to the educational quality of the task yielded only one study that incorporated learning outcomes. Fries, Horz, and Haimerl (2006) found that manipulating students' impressions of the educational task affected how well they performed on a post-activity assessment of knowledge. Would these results be replicated in a similarly designed study?

More research is needed to ascertain whether and how first impressions are able to make a difference in how well students actually learn from their computer-based educational experiences. The research investigation builds upon existing research by providing additional work in this area that addresses these aspects of impression formation along with measurable learning outcomes.

1.3.4 Student Population and Educational Topic

Past work addressing impression formation and measured learning outcomes from interactions with computer-based media has studied university students in the domains of psychology (Cheon & Grant, 2009), biology (Um, 2009; Um, Song, & Plass, 2007), and computer science (Fries, Horz, & Haimerl, 2006). This literature base is also in need of further expansion. Building upon work from a pilot study (Manning, Lawless, & Mayall, 2011), this research examines this area of inquiry with university students enrolled as pre-service teachers.

The chosen population of participants for this study serves to provide additional insight with respect to first impressions and learning because these students, whose academic concentration revolves around the specifics of learning and instruction, bring with them a perspective that is quite different from the participants recruited for past research. These pre-service teachers learned about genetics. In this case, the chosen topic is in the same general domain (biology) as research by Um and colleagues (2007, 2009), where students learned about the immune system. Keeping within a common domain allow for some comparison across samples, a means for examining more closely the ways in which first impressions may affect the thoughts and behaviors of different types of individuals with respect to the learning process.

1.3.5   Student Attributes and the Incorporation of Expectancy-Value Theory

The consideration of student attributes in understanding how interactions between the learner and the particular learning context can affect performance and learning outcomes has proven quite useful in areas of digital as well as traditional modes of learning (Artino, 2008; Chen, Fan, & Macredie, 2006; Lawless, Schrader, & Mayall, 2007; Schrader, Lawless, & Mayall, 2008). Because learner characteristics of individual students can influence the effectiveness of different modes and presentations of instruction, they should be a point of consideration regarding first impression effects with respect to educational computer-based media.

The highly visual aspect of interface design, for instance, makes for more varied and subjective reactions from viewers, along with any accompanying judgments those viewers form about what they are viewing. It would therefore be useful to consider how the visual presentation of computer-based instruction might elicit different impressions about the instructional

experience with respect to different learner characteristics. Likewise, different learners may act upon given information pertaining to the quality of the educational resource in differing ways. To begin to truly understand the real-world complexities behind the interrelations of environment, student thought, and student behavior, steps toward gaining a better grasp of how student attributes might moderate the first impression effects brought about by the implementation of a computer-based instructional task is in order.

Modern expectancy-value theory (Eccles et al, 1983; Eccles & Wigfield, 2002; Wigfield & Eccles, 1992, 2000) addresses these concerns by acknowledging and taking into account the individual differences learners bring to bear in a particular learning situation. The model (Eccles & Wigfield, 2002) is comprehensive, addressing elements such as: the cultural milieu in which the student has been developing, related prior experiences, and even students' short-term and long-term goals. In addition to these aspects of the learner, the model includes constructs related to impression formation by way of students' perceptions about a forthcoming task. According to the model, all of these items feed into and influence students' expectancies (expectations about one's ability to succeed at the task) and task values (the value perceived in doing the task). It is theorized that these two constructs together ultimately affect students' achievement-related choices and performance with respect to the given learning situation or task.

Examining the effect of first impressions on how well students are able to learn with computer-based media through the perspective of expectancy-value theory also serves to validate the theoretical model in ways not yet explored. In their last discussion of this theory, Eccles and Wigfield (2002) put forth a call for increased focus on the influence of the contextual elements of a task as a next step, and the present research aimed to do just that. Additionally, past work on the development and this model and the validation of its use has focused on learners in the

primary grades (Eccles et al., 1993; Wigfield at al., 1997; Wigfield, Eccles, & Rodriguez, 1998). Studying the model with respect to adult learners in the domain of digital learning provides new and useful information about its application by broadening the range of both student population and modes of instruction.

1.3.6   Contrasting Modes of Impression Formation

This research investigates the effects of two vehicles of first impression formation, each representing a different channel leading to the first impression effect: (1) the aesthetic elements of computer interface design and (2) verbal information pertaining to the educational quality of the task. As mentioned earlier, both were chosen due to their controllability as contextual elements of the task and its presentation to potential learners. Additionally, the inclusion of both modes of impression formation allows for the examination of interactions between the two and how one might function to offset or enhance the effects of the other.

To illustrate, the selection of instructional computer-based media available for use today ranges in appearance from work created by trained, professional multimedia and graphic designers to that of teachers who originally took it upon themselves to build homemade websites for their students' use. How might an aesthetic design treatment of professional quality versus one created by an untrained designer influence students' initial impressions and learning outcomes from a computer-based lesson? Would events unfold differently if students were also informed that the task was of high quality (or of low quality) by an external source in each of these cases?

A better understanding of these two modes of first impression formation *in conjunction with each other* would help educators and developers make more informed decisions about how

best to allocate resources in the production and implementation of computer-based instruction, for example: Would it be worth it to expend extra time, effort, and funding on the visual aesthetics of the interface for a particular educational task? Or would it suffice just to introduce the task to students as being of high caliber and as a huge success with past students? Based on answers to such questions, educators and developers would have additional means through which to influence students' learning experiences for the better. This research addresses issues such as this as part of its contribution to the related literature on first impressions and learning with digital media.

1.4   Purpose of the Study

This research investigates whether and in what ways students' initial impressions can influence learning outcomes from an educational computer-based task in order to uncover how first impressions, which are a common element to all educational tasks, may be leveraged toward better quality educational experiences with computer-based learning environments. The effects of impression formation are explored in terms of the *self-fulfilling prophesy* (Merton, 1948), where the impressions people form about a situation—which may or may not be accurate— evoke behaviors that actually confirm those beliefs. Through the lens of the expectancy-value theory of achievement motivation (Eccles et al, 1983; Eccles & Wigfield, 2002; Wigfield & Eccles, 1992, 2000), this study looks at how different channels leading to this phenomenon (interface visual aesthetics; verbal information about the quality of the educational resource) may affect different aspects of the learning process, and ultimately how well students learn with the task. This is accomplished by examining how students' specific perceptions and reactions, elicited through each channel, relate to their behaviors with respect to the task and resultant

learning outcomes.

1.6   Research Questions

RQ1.1. Can students' 'impressions of an educational task' be measured in such a way that this construct is successfully operationalized with respect to the characteristics of the task that speak to its quality?

RQ1.2. What underlying dimensions might exist with respect to students' impressions of a computer-based educational task?

RQ2. After equating groups with respect to prior knowledge and individual interest in genetics, do interface visual aesthetics, verbal information pertaining to the quality of the educational task, or combinations of different conditions from both factors have an effect on:

RQ2.1 *students' first impressions of the task?*

RQ2.2 *their expectancies and how they value the task?*

RQ2.3 *their achievement-related choices with respect to the task?*

RQ2.4 *how well they learn with the task?*

1.6 *Summary*

This chapter served as an introduction to this dissertation research, an investigation aiming to gain a deeper understanding of the effect of first impressions with respect to learning outcomes from a computer-based instructional task. This research examines two aspects of impression formation, each related to the design and implementation of the task. Students' impressions, behaviors, and resultant educational outcomes are studied through the lens of expectancy-value theory (Eccles et al, 1983; Eccles & Wigfield, 2002; Wigfield & Eccles, 1992, 2000). Chapter Two takes the form of a literature review, building upon the ideas discussed here and providing the reader with more depth of understanding in this area of study.

CHAPTER 2

REVIEW OF RELEVANT LITERATURE

"A bad beginning makes a bad ending."

- Euripides (480-406 BC)
  Last of the three great tragedians of classical Athens

"First impressions are a constant in society. However, their product, the period that proves or disproves their validity is not; good ones are pleasant and long lasting, bad ones long and difficult to disprove."

- Diego Velasquez (1599-1660)
  Leading artist in the court of King Philip IV of Spain / III of Portugal

2.1   Introduction

The influential power of the first impression is a phenomenon long regarded by people throughout time. Although fleeting in nature, the unavoidable first impression can have long-term effects, good or bad, affecting the future of individuals ranging from the one to the many. To begin to understand its potentially far-reaching effects, consider what is at stake when the first impression occurs. In education, for example, first impressions can mean the difference between students who come to know and care about what they know versus those who remain apathetic about what they might have known.

Today, issues related to impression formation and the consequences thereof involve an additional layer of complexity. Face-to-face interactions between human beings are not always available or feasible, but modern affordances allow for alternative experiences that can serve as an adequate proxy (when well-designed and executed, of course). For instance, 21st century educational practices and offerings include pedagogical options that allow students to learn with

 stand-alone computer-based instruction. Without the assistance of human instructors to guide students in their thinking as they engage in the task, however, the need for investigation into methods through which computerized instruction may be optimized for successful, high quality learning experiences demands attention.

To illustrate, consider the notion that people form and act upon their expectations regarding whatever situation they happen to face at any given moment. Jones (1986) discussed how these expectations are sustained or modified through the interactions that occur between the perceiver and the 'target person' involved, ultimately resulting in the particular nature of the long-term relationship that eventually evolves. The sequences of interactions that occur between the two individuals, from the perceiver's initial expectation and onward, are mediated by the combination of the biases each brings to bear along with the series of behavioral exchanges that the two share as they continually react to each other and reassess the situation as it progresses. Because this type of complex social interaction is not yet an adaptable, packageable technology available for widespread use in educational media (let alone other domains), there exists a major limitation in the richness and breadth of the interactions that can occur between individuals and the (stand-alone) educational computer programs they use. At this time, such programs simply cannot think and behave in ways comparable to human instructors in terms of their ability to react, improvise, and problem solve in response to their students' motivational states.

In light of this limitation, it seems that students' perceptions of their experience with computer-based educational programs should be of great concern to educators. As stated earlier, people's behaviors are rooted in the expectations they have formed based on what they perceive the situation to be. What kind of expectations do students form about the programs with which they are about to engage and why, and how might these expectations then shape the nature of the

educational experience and the quality of learning that results? These initial perceptions comprise the notion of the 'first impression' as discussed in the opening of this chapter.

Capable of setting precedence for how situations in life may come to unfold, the phenomenal first impression has been known to influence all elements of what many consider to constitute the human condition: people's thoughts, feelings, and actions—classically referred to as the 'ABC of psychology' in terms of affect, behavior, and cognition (Ogden, 1930). The opportunity to learn occurs throughout one's life, yet whether actual learning is realized by individuals as a result of such occurrences is uncertain and dependent upon the particular situation.

So just how influential might the first impression be? Of interest in this research is whether and in what ways the initial impressions students form about new learning opportunities influence their achievement motivation and how well they learn, based on the particular presentation of the educational task. This is accomplished by examining students' perceptions of the task, the choices they make with respect to the task, and resultant learning outcomes. Because impression formation is also reliant on the characteristics individuals bring to the situation, the moderating effect of student attributes on this process are also considered. The first impression effect is examined in terms of two different channels that lead to this phenomenon: (1) interface visual aesthetics and (2) verbal (i.e., in the form of words, written or spoken) information pertaining to the quality of the educational resource. Both were chosen due to the relative ease with which they can each be controlled in terms of the design and implementation of computer-based instructional tasks.

First impressions with respect to interface visual aesthetics, for instance, can form in as little as 50 milliseconds, which is just 1/20th of a second (Lindgaard et al., 2006). In almost no

time at all, viewers of websites already of have a sense of whether they like what they see. What does this mean in terms of students' educational experiences? A study by Skadberg and Kimmel (2004) sought to examine students' web-based learning experiences with respect to Csikszentmihalyi's (1975, 1990) concept of flow. The website's perceived attractiveness was the most significant factor leading to the flow experience. The experience of flow, in turn, correlated with user reports of increased knowledge. It seems that the visual aesthetics incorporated into the design of the interface may play an important role in the experiences learners have in terms of both achievement motivation and how much they actually learn.

In addition to visual input, past research indicates that the impressions students form based on verbal information pertaining to the quality of the educational resource can also influence the educational experience. Fries, Horz, and Haimerl (2006) demonstrated that the type of information provided to first- and second-year computer science majors about the quality of a computer-based educational activity (i.e., a high-end, award-winning program vs. a 'student project' in need of improvement vs. the 'control' condition with no additional information provided) produced significant differences in how much students learned from the task. With prior knowledge taken into account, results revealed that the 'high-end' group learned the most, while the 'student project' group learned the least. The control group's scores fell in between those from the other two groups. Although all students engaged with the very same educational activity, the experimental manipulation of their perceptions about the activity had an influential effect such that different expectations about the impending experience lead to significantly different learning outcomes across groups. Because these outcomes were in alignment with the expectations students formed about the task (as set by the conditions to which they were assigned), it appears that a *self-fulfilling prophesy* (Merton, 1948) had taken effect, where

impressions about a situation—which may or may not be accurate—evoke behaviors that actually confirm those beliefs.

2.2   First Impression Effect as Self-Fulfilling Prophecy

In terms of education and the quality of instruction students receive, the self-fulfilling prophecy is not a new concept. It first gained attention in the area of educational research through Rosenthal and Jacobson's (1968) classic study *Pygmalion in the Classroom*, where teachers' expectations of their students were shown to have an effect on the gains those students made through an entire academic school year. Participants were students from one school, ranging in grade level from 1st through 6th grade. From these students, two conditions were created: a control group and an experimental group of 'spurter' students who were chosen at random. Teachers participating in the study were unaware of these two conditions. They were informed that during the present school year they should expect certain students (those in the experimental group) to be intellectual 'growth spurters,' based on results from the *Harvard Test of Inflected Acquisition*. No such test existed in reality; the information was provided to teachers with the purpose of instilling in them higher academic expectations from students in the experimental group. Students' IQ scores pre- and post- the experiment were examined for differences in gains over the course of the school year.

Findings showed a significant difference between the control and experimental groups where IQ scores of the so-called 'spurters' exhibited increased gains over those of their 'ordinary' control group peers. The trends in IQ gains suggest that this phenomenon is more likely to occur in the lower grades, as results were more pronounced at the 1st and 2nd grade levels. The experimenters speculated that this may have been because (1) younger students tend

to be more malleable and (2) teachers working at higher grade levels likely already had their own biases regarding well students would perform based on past performance and reputation. The effect of grade level, however, was found to be insignificant. In any case, results seemed to have confirmed the notion of the self-fulfilling prophecy and its consequences—*good and bad*—regarding whether students may or may not be performing at levels that reflect their true potential as learners and why. Due to its implications, this study kindled a flame that has fueled the production of both additional research and critical commentary related to the 'Pygmalion effect' (Braun, 1976; Brophy, 1983; Elashoff & Snow, 1971; Feldman & Prohaska, 1979; Jamieson et al., 1987; Jussim, 1989; Ritts, Patterson, & Tubbs, 1992).

Work by Clifford and Walster (1973), for example, examined the expectations teachers formed of students with respect to both educational and social potential when those expectations were tied to student attractiveness. Participants were fifth grade teachers who received and filled out a survey in which they predicted the characteristics of a fifth grade student based on that student's summary record and an accompanying photograph of the student. The same summary record was given to all teachers, for the research aimed to see if there would be a difference in the predictions teachers made based on student appearance. Twelve possibilities existed regarding the enclosed photograph. Half of the pre-vetted photos depicted an attractive child (three boys, three girls); half depicted an unattractive child (three boys, three girls). The survey asked participants for predictions about students' interpersonal skills, IQ score, the attitudes of the child's parents toward academic achievement in school, and the level of education they expected the student might achieve one day (e.g., 2 years of high school, Ph.D.).

Results showed a significant difference in teachers' perceptions regarding students' potential across all the survey items such that predictions about attractive students were more

positive than those made about unattractive students. These findings support earlier work that also involved Walster, now known as the 'What is beautiful is good' phenomenon (Dion, Berscheid, & Walster, 1972). Attractiveness was found to have a significantly positive effect on viewers' perceptions of others. In addition to the verbal information people may receive, the salience of physical appearance provides for a potentially potent nonverbal message that also contributes to the expectations a perceiver may form and then act upon in a given situation.

Although the Pygmalion effect has called attention to important implications with respect to the influential power of teacher expectations on the academic development of their students, one should also consider the criticisms regarding Rosenthal and Jacobson's (1968) work, which is not without controversy. Brophy (1983) argued that the type of expectation effects described the 1968 Pygmalion study would, in real life, be minimal in most classrooms. This is because the expectations of most in-service teachers regarding their students are generally accurate, based on valid information—*unlike* the conditions created by Rosenthal and Jacobson. Brophy also suggested that the unique, personal characteristics of individual students and how they interpret and respond to different social stimuli would also complicate matters as far as experimental results are concerned.

2.2.1   The Student as Pygmalion

A decade after the original Pygmalion study on teacher expectations (Rosenthal & Jacobson, 1968), new research by Feldman and Prohaska (1979) flipped the concept around by examining the effect of *student expectations* of their teacher. Participants were told that they would be taught two short lessons by a third year education major. They would then have the opportunity to evaluate both the lessons and the teacher. As part of the experiment, each

participant was told that there was a delay and to wait in the hall. At this time, a male confederate posing as a peer participant who had just finished the lessons would arrive and engage the actual participant in conversation about the teacher while filling out his evaluation form. In the 'positive expectation' condition, the confederate stated that the teacher was competent, friendly, and seemed like she would be a good teacher. In the 'negative expectation' condition, the confederate stated that the teacher was incompetent, ineffectual, and would not be successful as a teacher. After being taught, participants completed a short, written test on the lessons' contents before filling out an evaluation form identical to the one used by the confederate.

During the administration of the activity, various measures pertaining to students' attitudinal, learning, and nonverbal behaviors were collected. Results from analyses showed a significant difference between participants expecting a 'good' teacher and participants expecting a 'poor' teacher across all attitudinal measures about the qualities of both the teacher and the lessons she taught. Students expecting a 'good' teacher exhibited more favorable attitudes in their evaluations. Of the nonverbal measures, a significant difference was found between the two groups regarding the degree to which students leaned forward during the lessons, where students who expected a 'good' teacher tended to lean further forward than those expecting a 'poor' one. Assessment scores from only one out of the two lessons yielded significant differences in learning outcomes between the two groups, however, where those expecting a 'good' teacher earned higher scores. Even so, results support the notion that it is possible for students' expectations to have an effect on the learning experience.

Work by Jamieson, Lydon, Steward, and Zanna (1987) also examined the effect of student expectations regarding teacher competence on educational outcomes. Four classrooms of

11th graders served as participants in this study. Each class was taught a unit on oral and written

English skills by the same teacher, who was brand new to the school and therefore unfamiliar to

the students. Prior to experimental manipulation, data regarding student perceptions of the new

teacher were collected to confirm that the four classes did not significantly differ with respect to

initial perceptions or GPA. Two of the four classes were then randomly assigned to a 'positive

expectation' condition under which students took part in individual interview sessions, during

which time they were shown (bogus) exemplary teaching evaluations of the new teacher by her

past students. These participants were led to believe that the new teacher was highly capable and

motivated to teach the English unit. After the experimental manipulation, all students once again

completed the teacher perception questionnaire. The manipulation had succeeded in eliciting

significantly different perceptions from the experimental group about the new teacher in

comparison with the control group such that the teacher was perceived as more competent by

students in the experimental group.

Data consisted of students' nonverbal behaviors and two measures of student academic

performance: (1) students' overall final grade for the unit as determined by the teacher, with

performance, participation, effort, and attendance all taken into consideration and (2) scores for

all graded tests and assignments completed during the unit. With respect to nonverbal behavior,

results showed a significant difference between the two groups such that the 'positive

expectation' group exhibited not only more appropriate nonverbal behaviors, but also lesser

amounts of inappropriate nonverbal behaviors. Regarding academic achievement, a significant

difference was found between groups with respect to students' overall final grades, where

students in the 'positive expectation' group received better grades on average. With respect to

scores on tests and assignments, students in the 'positive expectation group' scored slightly

higher than students in the control group, but not significantly so. Although not definitive, results from these two studies suggest that student expectations about the quality of instruction they are to receive could have an effect on how well they actually learn. And similarly to Clifford and Walter's (1973) work discussed earlier, expectations in this regard have also been tied to physical appearance and perceived attractiveness (Gurung & Vespia, 2007; Hamermesh & Parker, 2005; Rinniolo et al., 2006).

For example, Gurung and Vespia (2007) examined the influence of instructors' personal characteristics on students' perceived learning as well as their course grades. Data were collected from undergraduate students of varying majors who rated and supplied information about various courses and university instructors. The variables measured instructor attributes such as attractiveness, approachability, and formality of dress. These three attributes were hypothesized to predict overall likability, another obtained measure. Other measures pertaining to students' course experiences were also collected: attendance, participation, and perceived course difficulty. To control for other influences, measures pertaining to student G.P.A., year in school, student gender, instructor gender, instructor perceived age, and class format were partialled out by way of stepped entries in a hierarchical multiple regression. Overall likeability of the instructor predicted a significant proportion of the variance in both course grade and self-reported learning. A second analysis was conducted using instructor likeability as the dependent variable to get a better sense how different instructor attributes contribute to overall likeability. Instructor attractiveness accounted for the largest proportion of unique variance (16%), followed by approachability (6%), attendance (5%), perceived course difficulty (2%), participation, (2%), and formality of dress (1%). All were significant predictors, $p < .001$. These findings suggest that perceived attractiveness may ultimately influence educational outcomes.

One could argue, however, that the data may not really reflect the effects of appearance (as intended) because all measures were collected within one sitting. It is possible that students may have rated well-liked instructors more favorably in terms of attractiveness as a function of liking and not necessarily the other way around. In any case, the issue of visual aesthetics and its effect on perception and learning is one in need of further exploration, along with the notion of the self-fulfilling prophecy as it relates to impression formation and students' educational experiences with digital media.

2.3   Impression Formation and the First Impression Effect

At the forefront of any experience, arguably, is the first impression, for there is a 'first time' for just about all of life's moments, which then serve to inform the nature of future, related experiences. According to Sherif (1936), the experiences people have are filtered by culture. People's perceptions and the impressions they form rely on reference points that are determined by cultural norms, stereotypes, expectations, prior knowledge, past experience, goals, mood, affect needs, and other characteristics. The nature of the formed impression, good or bad, can thus be ascertained with respect to the intersection of individual and situation, along with the particulars each brings to bear. It also follows that the formulation of good versus bad impressions would likely yield differing educational consequences, beginning with students' thoughts and feelings about the experience at hand and ultimately leading to their academic-related choices and performance outcomes. A discriminating understanding of how the thoughts and feelings indicative of good versus bad first impressions might serve to forge different paths regarding possible educational outcomes requires some background knowledge of social cognition as it relates to impression formation, discussed in the paragraphs that follow.

The study of people's perceptions with respect to how people think about and interact with the world around them falls under the realm of social cognition, where perceivers cannot help but be involved in the shaping of the impressions they form as they construct their own realities (Moskowitz, 2003). As discussed by Allport (1954) and Bruner (1957), people see and understand the world through the filter of what they already know by way of categorization processes, a way of depending on prior knowledge, attitudes, and past experience to quickly and easily make sense of all the stimuli that bombard them each day. The subjective nature of both perception and the experience of reality was also discussed by Piaget (1970), who popularized the concept of schemas as organizational structures for the knowledge that comprises categories within the mind, unique to every individual and therefore to individual learners.

A well-known example of the categorization process in action as part of impression formation is stereotyping, which generally refers to a form of person perception but can also represent the classification or categorization of situations, places, and other objects—including computer-based educational tasks and other forms of instruction. If a stereotype has been activated within a perceiver's mind, that stereotype then proceeds to influence what grabs the individual's attention and how information is then interpreted. It is easy to rely on the coarse overgeneralizations of the stereotype because it requires more effort to do otherwise (Allport, 1954), and a person's willingness to cling to this categorical structure can bring about a confirmatory bias such that information is processed in a way that confirms the stereotype (Moskowitz, 2003). Hence, the initial impression—the stereotyping of the object in question— can influence thought in such a way that the first impression poses long-term effects.

The 'first impression effect,' as conceptualized in this research investigation, has been studied and labeled different things in the literature, depending on the particular context and

manipulations involved. Building on the concepts of categorization and stereotyping, the following paragraphs describe notable ways that other research has examined the effects of impression formation.

First described by Tversky and Kahneman (1974) in terms of anchoring and adjustment, the anchoring effect is a first impression phenomenon in which different initial estimates or starting points bias people's judgments on some task. The final estimates produced from the task, which include the adjustments these individuals made based on additional knowledge of the situation, were still slanted toward the respective starting points. In this phenomenon, the 'anchor' serves as the baseline for further assessments of the situation at hand. Although perceptions of the situation may become more 'accurate' given additional information over time, they are influenced (or 'anchored') by whatever the initial perceptions—the starting point—may have been. The classic illustrations of this phenomenon (Tversky & Kahneman, 1974) dealt with numbers as estimates. But this concept has also been applied to person perception (Jones, 1979; Park, 1989), where inferences about a person's disposition/traits served as the anchor, or starting point, which then influenced the perceivers' subsequent thoughts and behaviors with respect to the perceived. Attempts to reevaluate or correct the initial assumption at a later point, similarly to the original research, also yielded biases toward the initial evaluations.

The influential nature of the first impression has also been described in terms of the halo effect (Asch, 1946; Thorndike, 1920), a phenomenon that occurs when a person's evaluation of another individual based on one trait influences how that person evaluates other aspects of that individual. To illustrate: if told that a woman is very smart, this might positively affect how people might then evaluate her other traits. For instance, a sarcastic comment by the woman may likely be perceived as witty rather than cruel. The judgment about this woman's intelligence has

led to a 'general impression' about her, which Asch (1946) labeled 'G.' This general impression cast a 'halo' around the woman that worked to shift subsequent evaluations about her other traits to coincide more closely to the initial trait evaluation, whether favorable or unfavorable. In this regard the halo effect is not unlike the anchoring effect with respect to person perception.

The halo effect has also been demonstrated with respect to attractiveness and person perception, dubbed the 'what is beautiful is good' stereotype (Dion, Bercheid, & Walster, 1972; Eagly, Ashmore, Makhijani, & Longo, 1991), where the visual cues provided by a person's appearance were shown to influence impression formation such that judgments about personality and likely behaviors tended to be more favorable when those individuals were perceived as being physically attractive. Ambady and Rosenthal (1993) demonstrated that other visual cues in addition to attractiveness, such as smiling, frowning, nods, and certain gestures—termed *thin slices of behavior* (Ambady, Hallahan, & Conner, 1999)—were also influential over the inferences that students made about teachers with respect to various personality traits and competence, based on video observations of those teachers.

In addition to the halo effect, Asch (1946) also discussed a primacy effect as a likely explanation for some of his findings, where the impressions participants formed about a person based on the particular order in which certain traits were read from a list—beginning with positively valanced traits (e.g., intelligent, industrious) and progressing to negatively valanced traits (e.g., envious, stubborn) or the *reverse* condition—led to inferences about the individual that were considerably different even though all traits read to both groups were the same. Asch described the primacy effect in terms of directionality, where the initial traits heard by participants established the direction of their impressions, which began to form before the other traits had even been read from the list. Subsequent traits to be read from the list were then

processed *in relation to* the already-established direction of the forming impression. Webster and Kruglanski (1994) described this effect as being reflective of individuals' need to quickly structure the qualities of the perceived into a coherent impression. Impression formation as a process is driven by this need, providing great efficiency in people's ability to 'size up' (rightly or wrongly) what they have encountered at any given moment. It imbues the encounter with meaning and value that people can then act upon, for better or for worse.

2.4 First Impression as Instructional Strategy

People's perceptions and expectations have been shown, time and again in the literature, to have some sort of relation with or effect on the outcomes that result in given situations. The mind automatically evaluates what it sees (or is made to see), effectuating beliefs, judgments, and preferences toward the object in question, often without conscious realization (Chen & Bargh, 1999; Duckworth et al., 2002; Norman, 2004; Zajonc, 1980). Universal among mankind, this is a phenomenon that can be leveraged in the design of learning systems more likely to provide the kinds of educational experiences and learning outcomes that educators hope to see. Obviously, the design of the instructional program itself in terms of its contents and functionality play a hugely important role in the quality and effectiveness of instruction; this has been well established. This research contributes to what is currently understood about effective instruction by examining a different aspect of the design of digital learning environments: the motivational effects of impression formation.

Motivation has been described as an internal process that activates, guides, and maintains an individual's behavior over time (Murphy & Alexander, 2000; Pintrich, 2003; Schunk, 2000, Stipek, 2002). According to Elliot and Covington (2001), it is what determines the selection,

persistence, intensity, and direction of behavior. Based on these definitions, it follows that for

something to be influential over a person's motivation to engage productively in the learning

process, it must have the ability to somehow persuade that individual that the effort is worth it.

Through their Elaboration Likelihood Model (ELM; Petty & Cacioppo, 1986a; 1986b),

Petty and Cacioppo describe how the quality characteristics of the deliverer of content

information can affect the degree to which that information is processed (elaborated upon) by the

receiver. Central to their model is the Elaboration Continuum, which ranges from low

elaboration to high elaboration. When conditions foster in people the motivation and ability to

process the information at hand, the likelihood of elaboration would be considered 'high.' Petty

and Cacioppo proposed two routes regarding the manner in which information is processed.

Because their work focused on content information that was meant to persuade its audience (e.g.,

argumentative essays), they dubbed these two channels the *central* and *peripheral routes to*

persuasion. At this point it should be noted that although content developed for educational

purposes may not necessarily be designed with persuasion as the end goal, the underlying

concepts regarding these two channels and how they relate to the *depth at which information is*

processed still apply to the issues and concerns of the present research investigation. Of

particular interest is the peripheral route of processing, which relies on perceptions regarding

peripheral cues: the more 'superficial' or 'surface level'-type information about the

deliverer/delivery of content, such as perceived credibility or attractiveness. The peripheral route

feeds into the central route, which involves the deeper-level processing of the content itself.

Work by Petty, Cacioppo, and colleagues (Heesacker, Petty, & Cacioppo, 1983; Puckett

et al., 1983) has demonstrated the influence of peripheral cues on the elaboration of content

information. For instance, Heesacker, Petty, and Cacioppo (1983) randomly assigned

undergraduate students to one of four conditions in a 2x2 study. Half of the students were led to believe that the content information they received came from a highly credible source: 'research conducted by the Carnegie Commission on Higher Education and chaired by a professor of education at Princeton University.' The other half was led to believe that the information came from a local high school journalism class and was chaired by a student in that class. Likewise, half of the students received content information containing a poor quality argument while the other half received information containing a high quality argument. Results showed that arguments (both high and low quality) were more carefully processed when they were associated with the 'highly credible' source.

In a similar vein, source attractiveness was also shown to have an effect on depth of processing (Puckett, et al., 1983). Undergraduate students received content information in the form of an essay from a source that was either high or low in 'social attractiveness.' The social attractiveness condition was manipulated by way of both a photograph and description provided to students about the author of the essay. Authors high in social attractiveness were depicted as being more physically attractive and as having better family backgrounds and more prestigious hobbies than their counterparts. As with the preceding study, the essays students received were either of high or low quality with respect to the persuasive argument. Results revealed that participants processed the content information of both essay types (high and low quality arguments) more carefully when the essays were attributed to the more socially attractive authors.

These results demonstrate the influential nature of 'peripheral' aspects of tasks on the 'likelihood of elaboration' regarding the relevant content. They also demonstrate the notion that high quality educational content may not be enough when designing for experiences conducive

to the learning process. It seems that the creation of more optimal educational experiences calls

for consideration of the task's contextual qualities in terms of impression formation and how

they relate to students' motivation to engage with the task. This requires a framework for

understanding that addresses the complexities of learning and achievement motivation in a more

expansive manner so as to also include the seemingly minor, contextual details about a given

task (as targeted by this investigation) that may in fact be impactful in some way on the learning

process.

2.5   First Impressions of the Educational Task and Achievement Motivation

Reflecting a social cognitive point of view that is situational in nature, the expectancy-

value theory of achievement motivation (Eccles et al, 1983; Eccles & Wigfield, 2002; Wigfield

& Eccles, 1992, 2000) addresses the issues raised above by placing focus on the educational task

and its role in shaping student performance and achievement-related choices. Of interest are

students' perceptions about why they would want to do the given task. The theory provides a

perspective that integrates the relationships between (1) environment and thought, (2) thought

and behavior, and (3) behavior and environment, all of which are components pertinent to the

first impression effect. This integral approach is evidenced through the consideration of many

elements that might be influential in some way on students' achievement motivation with respect

to the task in question. The substantial role of anticipatory thought in this theory—particularly

with respect to its emphasis on the value perceived by students in doing the task—is befitting to

the questions and issues to be examined by this research.

The expectancy-value model of achievement motivation (See Fig. 1) depicts a detailed

framework that captures the complexity of the person-situation interaction that occurs in the face

of an impending task. By including elements such as student aptitude, gender, cultural milieu, short and long-term goals, self-concepts, past experiences and memories, activity stereotypes, and even perceptions about socializers' beliefs and behaviors, the model attempts to account for the many ways achievement motivation for a task might be characterized. In so doing, this theoretical framework puts forth a comprehensive view of the phenomena it serves to explain. It is also versatile in that it can be applied toward specific tasks (as is the case in this research investigation) or more broadly, addressing academic achievement in a one-semester course, for example, or even more generally: within a domain of knowledge.

Expectancy-Value Model of Achievement Motivation
(Eccles & Wigfield, 2002)
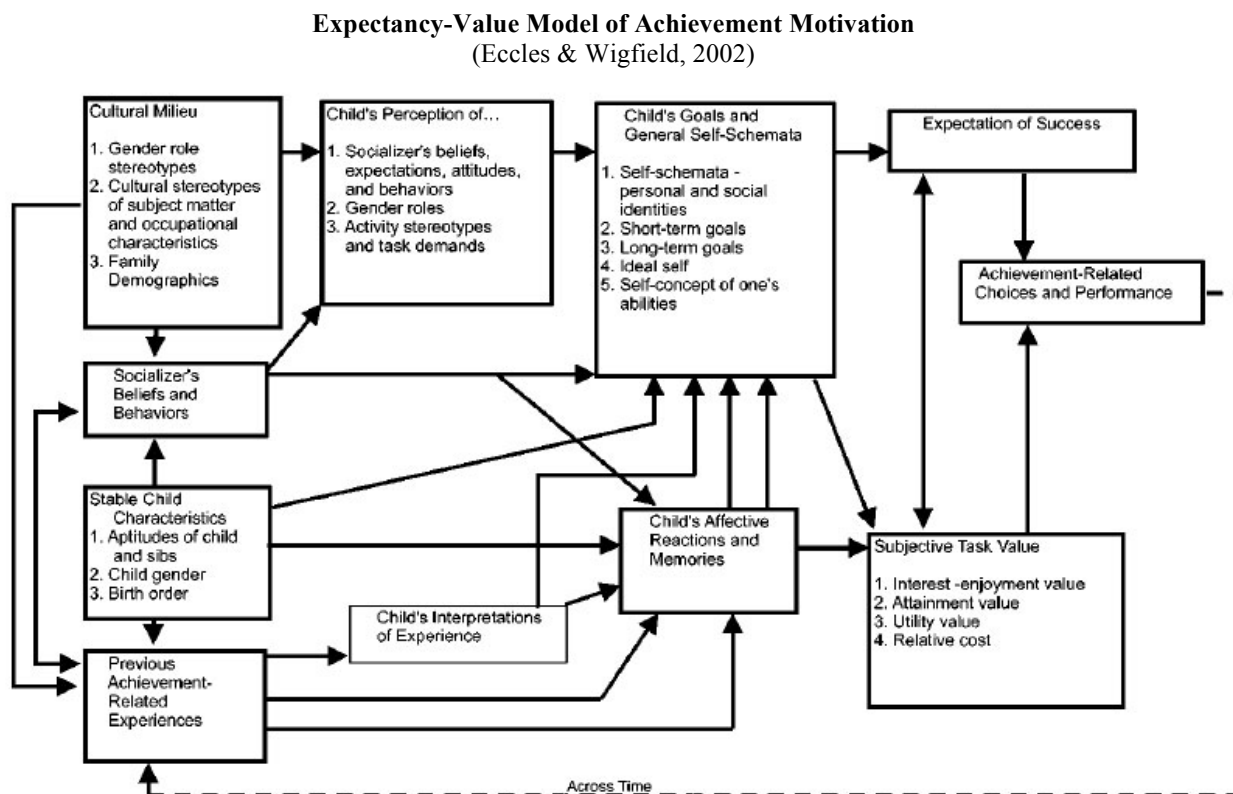
Figure 1

Of interest in this research is how the initial impressions students form about new learning opportunities influence their achievement motivation and how well they learn—based the particular presentation of an educational task. Therefore, attentions were placed on aspects of the model that speak to impression formation in terms of the contextual aspects of the task by way of the 'peripheral cues' (Petty & Cacioppo, 1986b) provided in its delivery and presentation that may influence students' first impressions with respect to its quality as an educational resource. So that the reader may understand with more clarity which elements of the model this research addresses in examining these issues, a streamlined version of the model is provided below (see Fig. 2).

Expectancy-Value Model of Achievement Motivation, Streamlined to Depict Constructs Examined in the Current Research Study
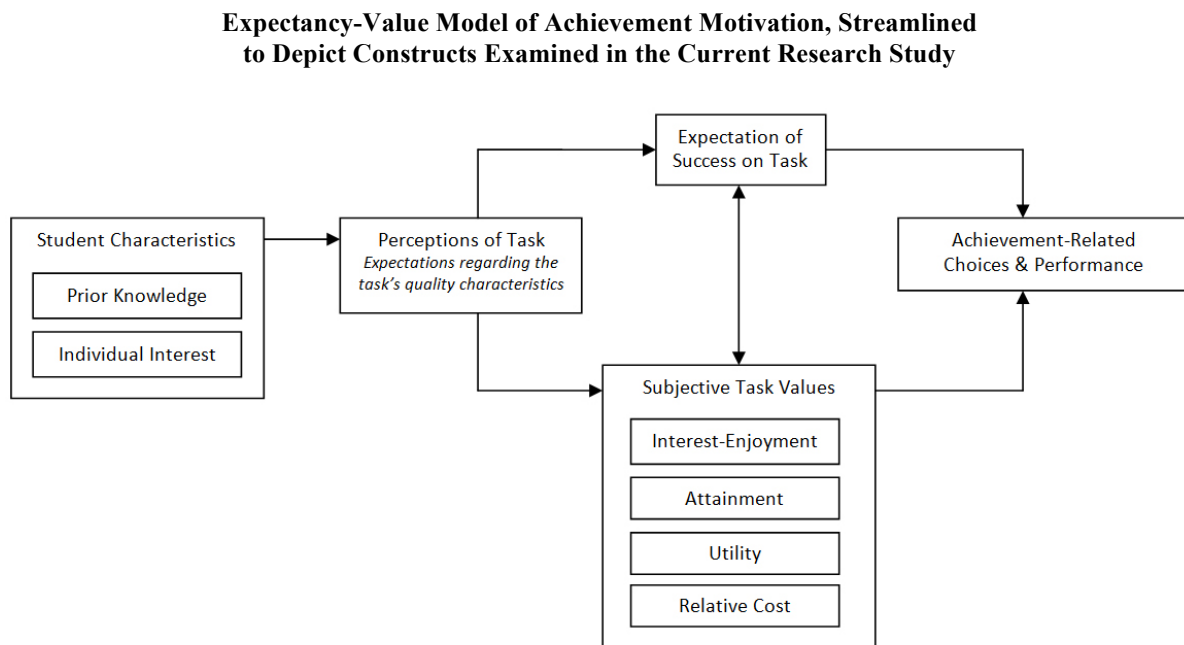
Figure 2

The possible effects of impression formation on students' achievement motivation and educational outcomes with respect to a computer-based task are reflected in the model as follows. Based on how they perceive the task, students develop expectations pertaining to the various quality characteristics of the task (e.g., task demands) with respect to the caliber and kind of experience it likely offers—in other words, impression formation occurs. These impressions of the task are then further processed by students with respect to self, producing *expectancies* (beliefs/expectations about one's ability to succeed at the task) and *task values* (ways in which students place value on engaging with the task). These two central constructs of the model are theorized to influence each other and link directly to the behavior-related final component of the model as predictors of achievement-related choices and performance. Given that expectancies and task values are the constructs for which this theory is named, it is important that the reader have a more precise grasp of their roles in the development of students' achievement motivation for a task. The next sections provide a more in-depth introduction to each of these two key constructs before launching into deeper discussion of how they interact and relate back to students' perceptions (impressions) of the task in question.

2.5.1   Expectations of Success and the Value in Doing a Task

Long recognized by achievement and decision theorists as an important determinant of behavior (Atkinson, 1957; Edwards, 1954; Lewin, 1936), concepts pertaining to expectations of success have been examined and described in various ways, becoming more refined through the years in terms of different constructs pertaining to predictions of success and how they are defined and related to one another. *Expectancies* in modern expectancy-value theory of achievement motivation (Eccles et al, 1983; Eccles & Wigfield, 2002; Wigfield & Eccles, 2000)

refer to students' expectations for success on a task. Students' expectancies can be thought of in terms of self-efficacy, *relative to the task at hand*: "Do I have what it takes to succeed at this particular task?"

The concept of self-efficacy is a crucial element in this theory, and in this respect it bears some similarity to Bandura's social cognitive theory (Bandura, 1986, 1989, 2001), which places great emphasis on self-efficacy as a theoretical construct. Bandura (1997) stated that individuals' efficacy beliefs are the foundation of human agency, with no other construct being more central or pervasive in its influence. People's efficacy beliefs, at the core, refer to whether they believe they have the power to make things happen, whether they have the ability to exercise control over a situation. Eccles, Wigfield, and colleagues' expectancy-value theory takes a perspective that is line with that of social cognitive theory regarding the influential power of individuals' self-efficacy, but the way it examines this construct is more narrowly focused. The expectancy-value theory of achievement motivation is future-oriented and focuses on students' expectancies as predictors of behavior with respect to the specific task in question (comparable to what Bandura (1997) described as 'efficacy expectations'), but the theory also accounts for efficacy beliefs on a more general level as part of students' self-concepts in its theoretical framework (see Fig. 1). The importance of expectancies for achievement-related behaviors (i.e., performance, persistence, and choice) has been demonstrated in numerous studies (e.g., Covington & Omelich, 1979; Eccles et al., 1983, 1993; Eccles & Wigfield, 1995; Feather, 1966; Wigfield et al., 1991, 1997). Work in this area has generally shown that students' perceptions of competence within a domain of study tend to decrease with age (Eccles et al., 1983; Eccles et al., 1993; Wigfield et al., 1991). Yet studies also indicate that the influence of expectancies on performance increases with age (Crandall, 1969; Eccles et al., 1983; Parsons & Ruble, 1977; Stein, 1971).

In conjunction with students' expectancies, the kinds of value students place on doing the task also serve to predict achievement-related behaviors. *Task values* take the characteristics of the particular situation into account and are defined in terms of how the qualities of a given task influence the individual's desire to do the task (Eccles, 2005; Eccles et al., 1983; Eccles & Wigfield, 2002; Wigfield & Cambria, 2010; Wigfield & Eccles, 1992). Within the task value construct, Eccles and colleagues (1983) defined four different sub-components of value, each addressing different types of reasons students might engage with a given task: intrinsic value, utility value, attainment value, and relative cost. *Intrinsic value* has been likened to the constructs of interest and intrinsic motivation as defined by Deci and Ryan (1985), Csikszentmihalyi (1990), and Schiefele (1999). It pertains to students' interest in and enjoyment of the task. *Utility value*, or task usefulness, refers to how students perceive the task as being relevant to their lives or helpful with respect to future plans and goals, for example: taking a course to meet the university's general education requirements. *Attainment value* reflects the personal importance of doing well on a task. Basically, tasks may provide students with the opportunity to confirm aspects of their self-schemas, for example: if a student identifies with being great at science, the attainment value of doing a science task for this student is likely to be higher than that of a student who has given up on the idea of ever being good at science. Lastly, the *cost* dimension of task values refers to what students may perceive as the negative consequences of doing the task, such as experiencing feelings of anxiety, expending an excessive amount of effort, or losing/wasting time.

2.5.2   Relations between Expectancies, Task Values, and First Impressions of the Task

Of importance to Eccles, Wigfield, and colleagues in the development of their theory of achievement motivation has been the movement toward a greater understanding of the relations between students' expectancies and subjective task values, along with their combined ability to predict academic performance and achievement-related choices. They believe that, in combination with a greater understanding of the role students' self-efficacy, a more solid knowledge base about *why* students would want to do a given task would provide useful insights for both educators and researchers regarding how and why people engage in the learning process.

In opposition to this perspective, social cognitive theory (Bandura, 1986, 1989, 1997, 2001) takes the stance that studying perceived value in outcome expectations is likely not a worthwhile a pursuit because (1) efficacy beliefs account for most of the variance in expected outcomes, and (2) people's decisions and performance with respect to perceiving value in an activity can ultimately be traced back to efficacy beliefs. In contrast with this view, Wigfield (1994) provided an argument in support of examining task values in addition to students' expectancies as predictors of academic behavior with respect to a task. When considering these two constructs from a developmental perspective, young children's competence and task value beliefs are relatively independent of each other. Demonstrated empirically in a longitudinal study by Wigfield and colleagues (1997), it is over time—throughout a child's development—that these two constructs come to be related. Therefore the relationship between expectancies and task values is stronger amongst older versus younger children (Eccles et al., 1983; Eccles & Wigfield, 1995; Wigfield et al., 1997). This is likely due to processes associated with behaviorist principles of conditioning: the positive effects of doing well become associated with success on the task (Eccles et al., 1983; Eccles & Wigfield, 2002). Additionally, lowering the value attached

to tasks for which one is not successful can be seen as a means for protecting and maintaining more positive levels of self-esteem (Eccles & Wigfield, 2002; Harter, 1990).

When examining the different dimensions of students' subjective task values in relation to expectancies, findings revealed that perceptions of ability were more strongly associated with intrinsic and attainment value than to utility value (Eccles & Wigfield, 1995). The authors suggested that utility value may be more influenced by other factors such as one's cultural values and beliefs. The cost dimension, in comparison with the other three sub-components of task value, has received little empirical attention. Recent research incorporating expectancy-value theory, however, has yielded some new insights regarding the cost dimension in terms of test anxiety.

Selkirk, Bouchey, and Eccles (2011) examined relations among expectancies, task values, and anxiety in the domains of math and English. Because the main question in their study pertained to how expectancies and values predicted test anxiety, anxiety was treated as a construct separate from task value rather than as a component of it. Findings showed that expectancies were significant predictors of test anxiety levels, even when controlling for previous levels of test anxiety. Sixth and seventh grade students who were more confident in their abilities in math or English reported less nervousness and fear about taking exams in these courses; likewise, students who were not confident in their ability to succeed in these courses demonstrated higher levels of anxiety. Additionally, students with *low expectancies* who also placed *high values* on success in the course reported the highest levels of test anxiety. Basically, the way students valued doing well in the particular domain had a moderating effect on students' test anxiety when expectations for success on the task were low. Interestingly, this work demonstrates that although expectancies and task values are positively associated, there are

certainly exceptions to the pattern.

Of course, for students to have expectancies and task values in relation to a given task, they must have already formed their impressions about the task itself. Whatever characterizes the given task will, from the student's point of view, speak to how that task is valued and how confident that student feels about engaging with it. Feelings of test anxiety, for instance, can be considered a cost of engaging with the task, but what was it about the task that brought the anxiety about in the first place? One possibility is students' perceptions of task demands, a task characteristic examined in past research (Eccles et al., 1993; Eccles & Wigfield, 1995).

Eccles and Wigfield (1995) found that perceptions of task demands were negatively correlated with both students' expectancy beliefs and positively oriented task values (intrinsic, utility, and attainment). In examining this task characteristic, Eccles & Wigfield measured two aspects of perceived task demands, which they found to be highly correlated: (1) perceived difficulty and (2) amount of effort required to do well. Interestingly, findings showed no relation between students' perceptions of task demands and their reports of actual effort exerted, suggesting that perceptions of task demands are not a major determinant of the amount of effort students put into a task and that there must be other more important influences at work here. This begs the question: what role might *other perceptions* pertaining to task quality characteristics play in the development of expectancies, task values, and achievement-related behaviors? For example, students may perceive of a given task as being: enjoyable to do, boring, or somewhere in between. The student who believes the task will be an enjoyable experience will likely engage with it in a different manner than the student who expects it to be a boring one.

It should also be understood that the notion of quality characteristics such as a task's perceived enjoyableness will have different connotations based on the grain size at which the

task is defined. When conceptualization of the task is at the very broad domain level or (slightly less broad) 'course' level of study—as has generally been the case thus far—perceptions of the task's quality characteristics must remain fairly generic because they represent an entire domain of study as it has been experienced by the student up until the present. At this 'macro'-level grain size, there is likely little difference between perceptions of 'a math class' and perceptions of math in general. A person's perceptions about a *particular* math activity, however, will not always align with his or her general perceptions about math.

At 'micro' level grain sizes, the perceptions—or impressions—people form about *specific educational tasks* are qualitatively different from perceptions pertaining to the larger domain of study. Perceptions at the micro level are more reliant on the contextual details that make up and define the individual task. Thus the impressions people form about two different math tasks, for instance, may vary quite a lot. The tasks, both of which fall under the domain of mathematics, might cover completely different topics, involve different kinds of activities and interactions, and require different time commitments from students (e.g., 20 minutes versus 2 hours). At the micro level, perceptions of the task are also more *relative*. For example, a particular math task might be perceived by an individual as: 'enjoyable!—*for a math exercise.*' It is possible that this person (who does not typically place high intrinsic value on doing math) might then put forth more effort than usual in engaging with *this* particular math task, which he believes will be more enjoyable than most other math-related tasks.

Still little is known about how perceptions of tasks at the 'micro' level may affect students' expectancies, subjective task values, and achievement-related behaviors. Clearly, this is an area ripe with opportunities for further exploration. Indeed, in one of their last discussions of this theory, Eccles and Wigfield (2002) put forth a call for increased focus on the influence of the

contextual elements of a task as a next step, and the present research does just that by targeting aspects of the task that contribute to students' first impressions of it.

2.5.3   Forward Movement with the Expectancy-Value Theory of Achievement Motivation

Thus far the major thrust of past work by Eccles, Wigfield, and colleagues has been: (1) to refine and confirm aspects their expectancy-value model of achievement motivation (Eccles et al, 1983; Eccles & Wigfield, 2002; Wigfield & Eccles, 2000) and (2) to gain an understanding of the formation of individuals' expectancies and values from a developmental perspective. Because of this, empirical work examining constructs as defined in their theory has generally taken the form of non-experimental studies in which questionnaires were provided to students (ranging from grades K-12) in waves, which—although informative and useful with respect to the theory's development—has not yielded data through which causal relations can be tested. (Eccles et al, 1983; Eccles & Wigfield, 1995; Wigfield et al., 1991, 1997). Unlike these past efforts, which have examined tasks at the 'macro,' or general domain level, this research examines students' achievement motivation for a task at the 'micro' level in order to gain a better understanding of how educational outcomes may be affected by the contextual elements offered by the specific task in question.

Given the goals of this research, the construct of impression formation and the role it plays in the development of students' motivational beliefs and values with respect to the task are explored in greater depth. In contrast with the relatively stable nature of students' achievement motivation at the overarching domain level of study, it is at the 'micro' task level where instructional design and details pertaining the creation of effective learning environments may be shown to make a difference in students' motivation to achieve. Additionally, studying

expectancy-value theory (Eccles et al., 1983; Eccles & Wigfield, 2002; Wigfield & Eccles, 2000) at the micro-task level lends itself to experimentation and the determination of causal relations. Aspects of individual tasks may be manipulated in order to gain a sense of the alternative outcomes likely to result from the respective conditions of the task, in terms of both student motivation and task-related choices and performance.

In changing the way a task is contextualized to students, questions pertaining to the *kinds* of perceptions and feelings students have about the doing task must be addressed, for example: How might the various ways in which a task can be perceived speak to students' impressions about its quality characteristics? What kinds of impressions are influential on students' motivation to achieve and they way they then engage with the task? If findings show that certain elements of a task's presentation or delivery—along with the impressions they evoke—can make a difference in the learning process, then a better understanding of how to construct learning experiences that make use of those particular impressions by way of the task's peripheral cues (Petty & Cacioppo, 1986) would prove quite useful in the design of instruction.

Working at the 'micro' (*specific task*) level also allows for a foray into 21st century learning practices and the examination of achievement motivation for computer-based tasks, as is the case for the current study. Modern demands of education often involve some sort of digital interactivity, and such processes occur by way of interactions between the digital medium and whatever the particular learner might bring to bear regarding the situation. Given these circumstances, a deeper knowledge base about how different learners may experience and learn with computer-based educational tasks would be useful in understanding the formation of students' achievement motivation with respect to digital instruction. The following two sections discuss this area of inquiry in more detail.

2.6 The Role of the Individual: Student Characteristics and the Process of Learning

Before students even develop 'expectancies' and 'values,' they come to the task as unique individuals with their own past experiences, memories, cultural identities, stable characteristics, self concepts, and goals. Reflected in the expectancy-value model of achievement motivation (See Fig. 1; Eccles & Wigfield, 2002), consideration of learner characteristics has proven quite useful in understanding how interactions between individual learners and the particular learning context can affect achievement motivation and learning outcomes. Regarding the current investigation, efforts are focused on examining the effect of student characteristics in terms of their *prior knowledge* and *interest* in the subject matter.

Past research on prior knowledge has shown that greater amounts of preexisting knowledge about a given topic will typically result in better comprehension and recall of the educational content (Chi & Ceci, 1987; Glaser, 1984). Prior knowledge has also been shown to be influential over the strategies learners employ (Dochy, Segers, & Beuhl, 1999; Thompson & Zamboanga, 2003). These findings demonstrate the importance of taking prior knowledge into account with respect to the kinds of educational experiences students may encounter, regardless of where or how they may occur: in the classroom or within less traditional digital learning environments.

Proper consideration of the effect of students' prior knowledge calls for a more nuanced understanding of the distinctions between different categories of knowledge, which serve to inform how best to measure this construct, given the goals of this study. *Topic knowledge*, for instance, refers to knowledge specific to the subject matter from the relevant content or text, whereas *domain knowledge* refers to knowledge that would be relevant to a field of study

(Alexander, Schallert, & Hare, 1991). Regarding their differences, Alexander, Kulikowich, and Schulze (1994) found that although topic knowledge and domain knowledge both predicted recall and interest in the topic, domain knowledge was actually the stronger predictor of the two.

As with prior knowledge, the construct of interest can also be conceptualized with respect to its two major sub-categories, specifically *individual interest* and *situational interest* (Ainley, Hidi, & Berndorff, 2002; Hidi, 1990; Hidi & Baird, 1988; Hidi & Renninger, 2006; Renninger, 1990; Renninger, Hidi, & Krapp, 1992; Schiefele,1991). *Individual interest* can be thought of as an enduring preference for and predisposition to attend to certain topics/subject matter and activities. In contrast, *situational interest* is context-dependent, an emotional state elicited by the content or structural components of the task as presented to its learners. Whether dealing with its 'individual' or 'situational' aspects, interest has been found to influence learners' attention, goals, and their levels of learning (Ainley, Hidi, & Berndorff, 2002; Alexander, 1997; Alexander & Murphy, 1998; Hidi & Renninger, 2006; Schiefele & Krapp, 1996).

Recent work by Hidi and Renninger (2006) ties these two conceptual components of interest together in a four-phase model of interest development, integrating situational and individual interest into a developmental spectrum beginning with the *triggering of situational interest* (phase 1), followed by the *maintenance of situational interest* (phase 2), the *emergence of individual interest* (phase 3), and ending with a *well-developed individual interest* (phase 4). It should be noted that this sequential model pertains specifically to the development of one's enduring interest in a specific subject matter over time; it does *not* preclude the occurrence of situational interest after an individual interest within the learner has already formed. As part of their theoretical perspective, Hidi and Renninger emphasize the situational aspect of situational interest, which can be triggered regardless of the learner's level of knowledge or individual

interest in a topic.

As the contextual component of the interest construct, the concept of situational interest appears to align with the process of impression formation with respect to a newly presented task. And in ways similar to the consequential effects of the first impression effect described earlier, situational interest can work for or against the learning process (Alexander, 1997; Alexander, Jetton, & Kulikowich, 1995). For example, it can attract students to new and unfamiliar educational content, catching and holding their attention (Mitchell, 1993; Schraw & Lehman, 2001). Likewise, it can distract from the important content when poorly aligned with instructional objectives; learners may instead focus their attentions on irrelevant or unimportant information, a phenomenon known as the seductive detail effect (Garner, Gillingham, and White, 1989).

In an attempt to integrate different concepts pertaining to motivation, Hulleman and colleagues (2008) drew parallels between aspects of students' task values as conceptualized by Eccles, Wigfield, and colleagues (Eccles et al., 1983; Eccles & Wigfield, 2002; Wigfield & Eccles, 2000) with the triggering of situational interest and the early stages of maintained situational interest as outlined in Hidi and Renninger's (2006) four-phase model of interest development. For instance, students may form the impression that a particular task will be fun to undertake (representing intrinsic value) or will prove relevant to future plans and goals (representing utility value). In both cases, one could say that situational interest has been triggered in these students, based on their initial impressions of the task.

Both individual and situational interest are addressed in a three-stage developmental Model of Domain Learning (MDL; Alexander, 1997), which focuses on the development of domain expertise, spanning from the position of novice to expert. It is a comprehensive lens

through which to examine how interest, knowledge, and strategy contribute to the process of learning within a domain. Students progressing through these stages can be classified as *acclimated* (stage 1), *competent* (stage 2), or *proficient* (stage 3). The *acclimated* learner has little or no knowledge about the given domain and therefore must focus on orienting him/herself to this unfamiliar terrain. *Competence* within a domain of learning is characterized by certain critical transformations in the learner's knowledge base, a level of individual interest in the domain, and strategic abilities to operate within that domain. *Proficiency* represents the highest level of attainment: expertise within the domain. A territory traversed by few travelers, it is a stage that calls for exceptional levels of knowledge, interest, and strategic processing.

Lastly, one should also consider that the development of interest and expertise may differ with respect to the field of study and the depth at which students invest in gaining knowledge within that area of study. By looking at knowledge and interest in individuals across different domains of study with respect to students' chosen area of specialization, Lawless and Kulikowich (2006) found that interest levels for different domains are likely influenced by the context of one's own area of academic specialization. Additionally, they found that the magnitude of the relationship between interest and knowledge may vary across domains, perhaps due to the particular nature of their study and practices.

2.6.1   Student Characteristics and Digital Learning Environments

As with traditional modes of learning, the study of student characteristics as they pertain to digital learning serves to inform the design of more effective instruction. This can occur by way of a better understanding of students' interactions with digital media and how the nature of these interactions relates to the learning process.

For example, learners with high prior knowledge tend to exhibit online behaviors that are markedly different from learners with low prior knowledge. Those with high prior knowledge are more focused and selective regarding the material they choose to view (Carmel, Crawford, & Chen, 1992; Dimopoulos & Asimakopoulos, 2010; Recker, 1994). This is not the case for learners with low prior knowledge. Because they have relatively little knowledge about the topic at hand, these learners tend to utilize the navigational structures embedded in the interface as a guiding path, resulting in more linear routes through the educational task (Barab, Bowdish, & Lawless, 1997). They are also more likely to be attracted to flashy features found within the web environment (Lawless & Kulikowich, 1996) and are in greater danger of becoming disoriented or lost (Rouet & Levonen, 1996).

These differences seem to speak to Bruner's (1957) notion of *perceptual readiness*, where the accessibility of information in a person's mind influences that person's 'readiness to perceive' and understand new situations. The influence of one's perceptual readiness on the learning process was illustrated quite clearly in research by Lawless, Schrader, and Mayall (2007) with respect to a computer-based educational task. For this task, students were asked to learn with an educational website on genetics. Participants were randomly assigned to either the control or treatment condition. Prior to browsing the website, those in the treatment group received a short text that outlined, at a high level, the major topics in the field of genetics. The intention was to: (1) provide readers with a general schema for genetics into which new knowledge from the website would be more easily integrated and (2) activate and enhance readers' already-existing knowledge of the topic. Participants in the control group did not partake in this pre-activity. Both groups were informed that they could interact with the website however they liked. As part of the research, students' navigational patterns were recorded for data

analysis. After equating both groups with respect to a measure of prior knowledge, results showed that the treatment group performed significantly better than the control group on the post-test of knowledge. Additional analyses revealed that the treatment group spent significantly more time using the website, viewed significantly more graphical representations, and followed a significantly higher number of hyperlinks found within the text narrative.

In a similar vein, Mandel and Johnson (2002) demonstrated how subtle differences in the presentation of web environments affected the perceptions of experts and novices in different ways—along with the choices they then made on a shopping task. In this case, the past experiences of expert versus novice shoppers differentially shaped the ways in which they perceived and acted upon the task. The same may hold true in the case of different learners' perceptions of an educational task and how they then engage with it. For example, Kang and Kim (2006) found that low-interest users actually consider the website's ability to entertain to be just as important as its ability to inform, while high-interest users perceived the site's ability to inform as its most important attribute. It is possible that 'subtle differences' in the design and presentation of a computer-based educational task may affect how learners think and feel with respect to that task. If so, how might the peripheral cues (Petty & Cacioppo, 1986) attached to an educational website's perceived ability to entertain or inform influence the behaviors students engage in when using the site? Might these initial impressions have longer-term effects in terms of how well students actually learn?

This research investigation aims for a better understanding of how differing levels of knowledge and interest might influence learners with respect to impression formation and, in turn, the development of these students' expectancies, values, choices, and performance regarding the task. The next section provides the reader with a deeper foundation of the current

knowledge base pertaining to impression formation and its study with respect to digital environments and computer-based educational tasks.

2.7   First Impressions of the Computer-based Educational Task

Today, modern educational practices and offerings include pedagogical options where students can learn more or less 'on their own,' with stand-alone computer-based instruction. Unlike traditional classroom instruction, through which the expectations students form about a learning situation are modified in ongoing, back-and-forth interactions that are moderated by the instructor, the sequences of interactions that occur between the student and the digital learning medium simply cannot be driven—in the same way—by the nature of behavioral exchanges that student and teacher share over time. Current technologies available for widespread educational use are just not comparable to human instructors' ability to respond to their students' motivational states in the most appropriate and effective manner.

Therefore there exists a major limitation in the richness and breadth of the interactions that can occur between students and the (stand-alone) computer-based educational tasks with which they attempt to learn. In light of this limitation, it seems that the phenomenon of the self-fulfilling prophecy would be *more* likely to occur in stand-alone digital learning situations, where interventions by human instructors regarding their students' expectations and attitudes toward the task are not an option. As discussed earlier, people's behaviors are rooted in the expectations they have formed based on what they perceive the situation to be. What kind of thoughts and feelings do students have about computer-based educational tasks with which they are about to engage and why, and how might the expectations that result then shape the nature of the educational experience and its outcomes?

To answer these questions, the first impression effect is examined through two different channels leading to this phenomenon that are both controllable and easily adjusted in terms of the task's design and delivery: (1) verbal information pertaining to the quality of the educational resource and (2) interface visual aesthetics. The paragraphs that follow discuss each of these aspects of impression formation at greater depth.

2.7.1   First Impression by Way of Reputation: Verbal Information Pertaining to Task Quality

Even before being exposed to the task in question, students' initial impressions about it may have already begun to form. The phrase "Your reputation precedes you" applies not only to people, but extends outward to anything that people can experience, including the educational tasks that students undertake.

Past work in traditional learning formats on the influence of information pertaining to the quality characteristics of the instructor or course has shown evidence of the first impression effect (Edwards et al., 2009; Griffin, 2001). To illustrate, college students who received favorable information about a course (by way of simulated ratings that were attributed to RateMyProfessor.com) just prior to viewing a video clip of simulated instruction from that course demonstrated significantly greater levels of both cognitive and behavioral learning with respect to nutritional concepts/content than students assigned to both the control and the 'negative information' groups (Edwards et al., 2009). Mean scores on these measures reflect results that support the notion of the self-fulfilling prophecy: students in the favorable information group averaged the highest scores; students in the negative information group averaged the lowest scores; and scores of students in the control group fell in between the other

two groups. In other words, students acted on the task based on the quality of educational experience they expected to receive.

Given the above findings, it follows that the nature of information provided to students about an upcoming computer-based task may have similar effects regarding the educational outcomes likely to result. This was certainly the case in research conducted by Fries, Horz, and Haimerl (2006), demonstrating that digital learning environments are no exception to this phenomenon.

Fries and colleagues manipulated students' expectations about a computer-based educational program with which they were about to engage. Participants were randomly assigned to one of three levels of expectation for the same learning system: (1) the 'high-end' condition, (2) the 'student project' condition, and (3) the 'no expectations,' or control, condition. The objective was to determine whether students' initial expectations about the quality of the program would influence their post-activity ratings about the program's quality as an educational resource and their performance outcomes on an assessment of knowledge. The computer-based educational program covered advanced material from an undergraduate curriculum in computer science. The participants, all computer science students, consisted of first and second-year undergraduates. Differences in students' prior knowledge of computer science concepts were taken into account as a moderating covariate. Data analyses showed significant differences between the 'high-end' and 'student project' expectation conditions for both dependent measures, indicating the presence of a first impression effect in which students' perceptions and learning outcomes were indeed influenced by their expectations regarding the quality of the computer-based educational program: participants with 'high-end' expectations scored higher for both their post-activity ratings about the program's quality and the assessment of knowledge

gain. Aligning with findings in the study by Edwards and colleagues (2009) above, mean scores for each group demonstrated a trend in support of the self-fulfilling prophecy. Fries and colleagues suggested that the differences in student performance could be attributed to differences in cognitive effort between the groups, as a function of expectations influencing behavior.

To determine the stability of this effect relative to the amount and depth of cognitive processing a particular learning experience may require, *learning scripts*, which are instructions and features designed to illicit deeper cognitive processing in the participants, were introduced by Fries and colleagues as an additional independent variable in a second study. The objective was to see whether a more cognitively demanding learning experience would negate or dampen the beneficial effects exhibited by the high-end group from the first study. New participants were recruited and randomly assigned to one of six groups. Three of these groups received the additional learning scripts; the remaining three did not. With the exception of the quality ratings survey, the three conditions of the first study were applied once more, to the groups with the additional learning scripts and to the groups without.

Results of the second study indicated a first impression effect similar to that of the first study, regardless of the addition of learning scripts: participants who expected to use a 'high-end' educational program scored significantly higher than those who expected to interact and learn with a 'student project.' The presence of learning scripts, however, did result in significantly higher scores across all three levels of expectancy conditions. The learning script group performed better on the knowledge acquisition measure than the no-script group. Results indicated that there was no interaction between the two independent variables, suggesting that the benefits of favorable expectations about the learning experience on educational outcomes can

take effect regardless of how cognitively demanding the educational program may be by design.

One can also think of the favorable information received by students in the above studies as a type of 'rationale for learning' that helps to elicit within them the motivation to engage with the educational task in a more productive manner. Jang (2008) found that students provided with a rationale for learning with an "uninteresting" educational task about correlations showed significantly greater interest-enhancing strategies, behavioral engagement, and conceptual learning than students in a control group who received no rationale. The rationale for learning as presented in Jang's work appealed to what Eccles, Wigfield, and colleagues (Eccles et al., 1983; Eccles & Wigfield, 2002; Wigfield & Eccles, 2000) would refer to as utility value for the task. In this particular study, the rationale was intended to counteract the task's uninteresting-ness by pointing out its usefulness to the students' lives. Rationales for deeper engagement with the task, however, can speak to *any* means through which students may find value in engaging with it (i.e., intrinsic, attainment, or utility values). Jang argued that externally provided rationales can play an influential role in fostering within students the motivation to act upon the educational task in ways that are more constructive and conducive to the learning process.

'Rationales for learning' need not be restricted to externally provided information. They can also be more subtle—embedded within the task itself and communicated *visually* to the learner. The next section discusses the influence of impression formation on learning with respect to the visual presentation of computer-based educational tasks.

2.7.2   First Impression by Way of Website Design: Interface Visual Aesthetics

In recent years, the existence and use of websites on the Internet has become an everyday norm of modern society. Issues pertaining to website design (and similar computer-based

applications) have therefore become of greater concern to both producers and consumers as aspects of website creation and development continue to evolve and grow more sophisticated with each passing day. One such issue is the computer interface's visual design and how it communicates to viewers. Much of the past work in this area reflects concern surrounding the functionality and usability of computer-based tasks that speak to the effective structuring of digital information (i.e. site contents, navigational elements, task flow, issues of cognitive load) in order to facilitate the successful processing of that information so that students would be able to learn as intended (Lin & Dwyer, 2010; Mayer, 2005; Mayer & Moreno, 2003; Moreno & Mayer, 2000; Park, 1998; Pettersson, 2004; Rieber, 1994; Szabo & Kanuka, 1999). The information communicated to viewers through the interface design, however, extends beyond the aforementioned concerns.

Stoney and Wild (1998) once made the contention that the interface design of online instruction plays a strategically important role, influencing students' motivations for engaging with the task based on their perceptions of it. Assuming that needs pertaining to the task's usability, functionality, and cognitive load issues have been sufficiently met, one can begin to focus on how other aspects of the interface's design—such as its visual aesthetics—contribute to students' motivation to achieve. On trend with what Crilly, Moultrie, and Clarkson (2004) have described in the product design literature as a shift in emphasis toward aesthetics in design versus the more practical issues of safety, usability, and comfort, this research investigation examines the digital learning experience beyond the user's basic needs. In line with concepts behind Maslow's (1943) hierarchy of needs, Yalch and Brunel (1996) suggested that upon meeting the requirements of necessity, people's attentions will naturally turn toward other considerations for improved product performance. Moving past the basic requirements for

computer-based educational tasks to work as intended, the question becomes: *What makes for even more successful digital learning experiences?* Past work exploring how users evaluate websites provides some useful information on this topic.

Work by Tillotson (2002), for instance, investigated college students' ability to articulate criteria for website evaluation. Of the 499 participants, 26% provided no criteria for evaluation. The amount of criteria listed by the remaining 74% ranged from one to five, with a mean of 1.8. Of the five top criteria listed, the most popular by far was credibility of the source (e.g., comments pertaining to the site as being: reputable, recognized, trusted, respected), which accounted for 35% of listed criteria. Sixteen percent of the listed criteria referred to the quality of the site's content information; twelve percent of the listed criteria pertained to the site's appearance (most often with respect to its professionalism); eleven percent of the listed criteria had to do with the author of the site or article, although the specifics were not necessarily provided; and finally, 10% of listed criteria referred to whether references for the content information were posted on the site.

Albeit less sophisticated, the evaluation criteria in above findings are not too different from those of university faculty and graduate students (Blumberg & Sparks, 1999; Cottrell, 2001; Rieh & Belkin, 1998). In addition to the criteria listed by undergraduates in the above study, faculty and graduate students listed criteria pertaining to: indication of peer review, verifiable content, and quick loading time. Somewhat similar to undergrads' responses, 'good design' was listed with respect to both appearance and organization of content. In contrast, research on younger students (ranging from grades K-12) shows that students in this age group tend to evaluate websites based on whether they contain relevant content and good pictures (Bowler et al., 2001; Fidel et al., 1999; Hirsh, 1999; Kafai & Bates, 1997).

It should be noted, however, that the notion of 'website evaluation' and its practice (as discussed in the paragraphs above) originated within the field of information science. There are alternative ways through which people consider and judge the websites they use. For example, Hughes, McAvinia, and King (2004) were interested in finding out "what really makes students like a website." A questionnaire was distributed to students aged 14-18 at nine different schools. The most common reasons students gave for liking a site was its content and functionality. The next most commonly given reason was the site's ease of use. Comments pertaining to aspects of the site's appearance also occurred frequently; color and layout were the most commonly mentioned, followed by graphics and pictures. Lastly, fun—not surprisingly—was also mentioned frequently as a reason for liking a website.

Focus groups were also conducted as part of this research, which provided more nuanced information about the students' preferences. "Lots of text" was unanimously off-putting, and students were able to articulate the attribution of this negative quality to the *arrangement* of text as opposed to its quantity. When discussing visual attributes of websites, color was the attribute most frequently mentioned by students. The appropriate use of color was discussed, for students felt that certain colors were "patronizing" yet they still wanted for the site to speak to them as "kids." The issue of photographs versus cartoon images was a point of debate regarding appropriateness for the audience (in this case, 14-18 year olds), but its resolution depended more on the context is in which the images were applied. The students also stated that they liked graphics that were "eye-catching" but not too "in your face." These strong opinions about the way 'likable' websites should look suggest that a website's appearance, particularly its visual appeal to the user, plays an important role in the experience of using it.

Even so, aesthetic appearance is a characteristic that people tend to regard as being

relatively unimportant in terms of product choice (Diefenbach & Hassenzahl, 2008). People's

behaviors, however, appear to belie that notion. For example, Fogg and colleagues (2003)

investigated what causes people to believe (or not believe) information found online. One of the

major goals of their research was to see whether and in what ways website users actually

performed the processes typically involved in determining a website's credibility (e.g., looking

for source citations; evidence of author expertise; existence of a privacy policy). In this study,

over 2000 participants evaluated live websites that spanned across several domains

(entertainment, finance, news, sports, travel, search engines, e-commerce). Findings suggest a

mismatch between what people say and what they actually do: when assessing a website's

credibility, participants rarely used rigorous criteria. Instead, nearly half (46.1%) relied heavily

on the superficial aspects of the websites—such as their visual appeal—to make decisions about

credibility. As part of their evaluations, participants mentioned characteristics such as the

website's overall visual appeal, layout, typography, font size, and color schemes. Similar

findings regarding perceived credibility resulted from work by Flanagin and Metzger (2007),

Manning, Lawless, and Mayall (2011), and Robins and Holmes (2008), where websites with

higher quality aesthetic treatments were judged as more credible.

Although people may not place a high value on a product's aesthetics in terms of choice

(Diefenbach & Hassenzahl, 2008), the impressions people form and the judgments they make

based on website aesthetics suggest that the aesthetic aspects of computer interface design are

more important than people realize. As first impressions go, the interface's visual aesthetics are

used by viewers as a heuristic through which to quickly judge other aspects of the site such as its

credibility. It is therefore quite possible that judgments about other quality characteristics of a

computer-based program may also be based—at least in part—on the aesthetic aspects of the

interface design.

As with the design of other products that people buy and consume, so too should visual aesthetics be considered in the design of computer-based instruction in order to provide the best possible experiences for students. For example, Wheeler (2009) discussed the design of brand identities through the strategic use of graphic design to elicit certain perceptions of meaning and value in the viewer's mind. The same considerations could also apply to the design of computer-based instructional media. The strategic design of a person's experience in this manner has been examined in ways that speak to the present research, through product design and the user experience (Norman, 2004; Norman & Ortony, 2006).

Norman and Ortony (2006) outlined three levels of design and user response to products: visceral (perceptually based), behavioral (expectation based), and reflective (intellectually based). The *visceral level* refers to the design of a product's surface-level features (product appearance); it also refers to the user's reaction, an automatic evaluation based in the innate biology of the human mind that speaks to 'good versus bad,' 'approach versus avoidance.' The *behavioral level* of design refers to the function and usability of a product. Behavioral responses speak to the user's expectations and predictions about interacting with the given product. Norman and Ortony posited that the designer's work has a direct influence on user response at the visceral and behavioral levels. This is not the case at the *reflective* level, however. The designer's influence tends to be indirect at this level because much thought stems from the individual user, whose tastes may vary depending on the situation, prior knowledge, and the particular concerns that may exist at that moment. This includes the user's ability to reflect on why a certain product is appropriate or desirable with respect to oneself.

Work by Coates (2002) elaborated upon this notion by discussing how products have the

ability to communicate with consumers by way of their design details, which may or may not resonate with the particular individual. The message communicated through a product's design is what allows users to determine whether the product is 'for me' or 'represents me.' According to Coates, "Watches tell more than time." Similarly, the interface design of an educational website may or may not send a message that connects favorably with its users. This connection, or lack thereof, ties back to the formation of students' expectancies and values for an impending educational task, based on their impressions of it (Eccles et al, 1983; Eccles & Wigfield, 2002; Wigfield & Eccles, 2000). For example, the impressions students form about an educational website embellished with high-end, professional-looking graphical treatments are likely different from the impressions students form about a website that has not received that level of treatment regarding its visual design. In other words, expectations about the former may be perceived by students as more worthwhile than the latter—in terms of both expectancies for the task and the kinds of value placed on engagement with the task (attainment value, utility value, intrinsic value, and cost).

Given that people will process and interpret whatever a particular product design may convey, it is no wonder that Hassenzahl and Tractinsky (2006) put forth a call toward an increased focus on researching the *user experience* (UX), an outward expansion from the more traditional notions of human-computer interaction. Tractinsky (2005) described this movement as a struggle between logic and intuition, for traditional HCI—with its logical approach—has generally tended to marginalize aesthetics. Drawing upon concepts from Maslow's (1943) hierarchy of needs, Tractinsky pointed out that the need for aesthetics actually increases the more it is satisfied because people naturally and continually seek out improved and more satisfying experiences. In this sense, visual aesthetics in computer-based educational tasks can be

considered a motivational factor in the user experience.

Zhang and von Dran (2000) illustrated this notion with their two-factor model for web design and evaluation. They proposed two types of web design factors, hygiene and motivator. *Hygiene factors* speak to usability issues, the necessary elements that allow the website to function correctly. The absence of hygiene factors would cause user dissatisfaction—in such instances, they are 'dissatisfiers.' *Motivator factors*, in contrast, add perceived value to the user experience by increasing one's level of satisfaction. Thus motivator factors (i.e., enjoyment, cognitive outcomes, credibility, visual appearance, user empowerment, and organization of information) are considered 'satisfiers.' In a similar vein, Huang (2003) identified website attributes with respect to their utilitarian and hedonic aspects, concluding that website designers should aim to support both in order to optimize the user's overall experience.

Also along the same lines, but focusing specifically on the communicative nature of aesthetics in website design, Lavie and Tractinksy (2004) performed exploratory and confirmatory factor analyses that yielded two dimensions of perceived visual aesthetics: classical aesthetics and expressive aesthetics. *Classical aesthetics* pertain to notions of aesthetics that emphasize order, clear design, and other principles that tend to align with rules for website usability. The *expressive aesthetics* dimension, on the other hand, refers to creativity and originality in visual design.

Regardless of the terminology employed (hygiene, utilitarian, or classical; motivator, hedonic, or expressive), it appears that the common goal across these studies was to gain a better sense of how various elements of computer interface design meet, exceed, or fail to succeed regarding different aspects of the user experience.

2.7.3   Research Addressing Both Interface Visual Aesthetics and Learning

Although the literature base pertaining to research addressing both interface visual aesthetics *and* learning is still nascent, the existing literature do provide useful information regarding this area of study. Sutcliffe and De Angeli (2005), for example, utilized Lavie and Tractinsky's (2004) two dimensions of perceived visual aesthetics as a lens through which to examine university students' preferences and academic performance with respect to two educational websites on astronomy that presented the same content information though a 'traditional menu' interface design versus an 'interactive metaphor' design. All participants had basic knowledge of usability requirements and website evaluation based on a previous course. Additionally, all participants worked with both websites, which were counterbalanced in presentation. The traditional menu version of the interface displayed typical, tried-and-true website conventions regarding layout and navigation (i.e., a horizontal menu bar near the top of the screen). In contrast, the interactive metaphor website's interface featured a spaceship cockpit with navigational controls, along with clickable planets that were viewable through the cockpit's window.

Results showed that although all users reported the usability of the metaphor-based website interface as being inferior to the menu-based interface, nearly all of them also indicated a preference for and a willingness to reuse the metaphor-based site over the menu-based site. Scores with respect to expressive aesthetics were significantly higher for the metaphor-based interfaces, whereas classical aesthetic measures were roughly the same for both interface styles. These results indicate that the manifestation of expressive aesthetics in interface design have a relationship with perceived appeal such that users are willing to forgo better usability in favor of higher aesthetic value. Regarding measures of knowledge gain, users' performance on a recall task yielded no significant differences between the interface styles. Even so, these results suggest

that the choice to use the metaphor-based interfaces would not jeopardize knowledge gain in terms of recall ability. A limitation of this study, however, is that the manipulations confounded aesthetic appeal with the layout and functionality of the interface. Although the content information presented through the two websites was held constant, it was some *combination* of functionality and visual aesthetics of the interface design that affected learners' experiences and preferences.

As exemplified through the above research, determining how visual aesthetics might engender more (or less) successful learning outcomes is in some respects a challenging endeavor, for the visual aesthetics of computer-based media are enmeshed seamlessly into the overall design, entangled with other elements such as functionality and content (Manning & Lawless, 2011). Much work in the past has investigated interface aesthetics either through the comparison of several non-related websites (yielding observed trends and patterns) or through the examination of specific elements of the interface, such as button placement (Hsu, 2006; Lavie & Tractinsky, 2004; Lindgaard, et al., 2006; Schenkman & Jonssons, 2000; Sutcliffe & De Angeli, 2005; Tractinsky et al., 2006; Tractinsky, Katz, & Ikar, 2000;).

On one hand, examining visual aesthetics by way of a broad survey of interface designs has served to uncover valuable information about the role of aesthetics in the visual appeal and interpretation of various computer-based media. On the other hand, work that has focused on particular elements of the interface has provided knowledge about various nuances of the user experience as supplied by distinct components of the interface. There is no doubt as to the usefulness of these studies, which have approached the study of interface aesthetics from both top-down and bottom-up perspectives. The question of impression formation at the level of *visual aesthetics alone* still exists, however, for the very nature of computer-based media and

how it is designed makes controlling for differences that are *purely visual* in terms of aesthetic design—and not tied to functionality or content—a somewhat inconvenient pursuit. Yet the literature does yield examples of work attempting to address the isolation of visual aesthetics in educational computer-based tasks (Cheon & Grant, 2009; Manning & Lawless, 2011; Manning, Lawless, & Mayall, 2011; Skadberg & Kimmel, 2004; Um, 2009).

Manning and Lawless (2011) examined first impressions of different aesthetic treatments for the same web-based lesson about trench poetry from WWI. Holding site content and functionality constant, the interface design's visual presentation was manipulated along two dimensions: (1) Design Positioning and (2) Design Novelty. Design Positioning manipulations were performed with respect to Aesthetic Value (Good, Poor) and Gender Orientation (Masculine, Feminine, Neutral). Design Novelty manipulations yielded three styles pertaining to perceived currency of design: Contemporary, Dated, and Outdated. Together, the different manipulations produced 15 different visual presentations of the same online lesson. Undergraduate students enrolled in a course on western civilizations rated each design with respect to appeal. Afterward, they indicated the design they most preferred for further engagement with the web-based lesson.

A rank ordering of means regarding students' ratings of visual appeal for the five Design Positioning treatments showed that students preferred the Good Aesthetic Value designs the most and the Poor Aesthetic Value designs the least. Falling in between were the Gender Orientation designs, for which the Masculine design ranked the highest, followed by the Neutral and then the Feminine design styles. These results reflect not only students' preferences for more attractive aesthetic treatments, but also how students interpreted the appropriateness of visual design for an educational topic addressing a war fought by men. Students' visual appeal ratings also revealed a

preference for the more modern Contemporary designs, followed by Dated and Outdated, respectively.

Unexpectedly, findings with respect to selected designs for further engagement with the lesson revealed that all three Feminine style designs (Feminine-Contemporary, Feminine-Dated, Feminine-Outdated) were among students' top choices. These results deviate from the mean rankings previously discussed. Further investigation revealed a gender difference in the designs students ultimately chose as their top choice, suggesting the employment of different evaluative processes by a subgroup of females within the sample who indicated preferences for the Feminine style designs. A possible explanation for these results is gender schema theory (Bem, 1981), where individuals identify so strongly with their gender that they exhibit a predilection and readiness to process information with respect to their gender schema. Given the design of this particular study, these results also seem indicative of students' desire to customize and personalize the task, a means through which to connect with or take ownership of the educational material in perhaps a more personally meaningful way—increasing its perceived value. Unfortunately, measures of learning outcomes were not collected as part of this research. Thus a major limitation of this work is its inability to follow up on how well students learned in conjunction with the interface designs with which they chose to learn.

Rather than creating multiple versions of a website's interface design, Skadberg and Kimmel (2004) used one interface through which to gather data pertaining to perceived attractiveness. Through structural equation modeling, Skadberg and Kimmel (2004) found that the website's perceived attractiveness had a very strong, direct impact on the user experience in terms of Csikszentmihalyi's (1975, 1990) concept of flow, which was measured with respect to enjoyment and time distortion (losing track of time) during the activity. In fact, perceived

attractiveness was found to be the strongest factor leading to the flow experience—more so than other collected measures (perceived ease of use, interactivity, and speed). The experience of flow, in turn, had a positive influence on users' perceptions of increased knowledge. *Perceived gains* in knowledge, however, do not equate actual knowledge gain. In any case, results from this research suggest that websites perceived by students as visually appealing may have the ability to influence the learning experience with respect to achieving the desirable state of flow, perhaps leading to better educational outcomes.

Thus far, work pertaining to both interface visual aesthetics and learning has fallen short with respect to either: (1) the isolation of aesthetics from content and functionality or (2) a means through which to evaluate how well students learned in relation to interface visual aesthetics. A thorough review of relevant literature bases has yielded just a few examples of research that have approached issues of impression formation and computer-based instruction in ways that attempted to address the isolation of visual aesthetics in interface design in order to examine its effect on actual (versus perceived) knowledge gain (Cheon & Grant, 2009; Manning, Lawless, & Mayall, 2011; Um, 2009). They are discussed in the following paragraphs.

Holding website content and functionality constant for an online lesson on "cognitive information processing," Cheon and Grant (2009) examined undergraduate education students' preferences (in terms of visual appeal) and learning outcomes based on their interactions with three interface types: text-based, graphical, and metaphorical. The *text-based* interface design employed the use of text only. Headers were accented through the use of colored text. Additionally, guidelines for typography (Lee & Boling) were followed to help ensure a usable interface (e.g., left-justified text, use of upper and lowercase characters, high contrast for readability, consistency in adopted conventions, etc.). Building on the strategies utilized for the

text-based interface, the *graphical interface* employed the use of rectangular shapes to group related pieces of information together and arrows to signify the direction of information flow. The *metaphorical interface* built on aspects of the graphical interface, such as the rectangular shapes, by making them appear three-dimensional. Additionally, metaphorical imagery was added. For example, an outline of the human head was used as the background image for content corresponding to the information processing model.

Findings revealed a significant difference between measures of appeal for the text-based and metaphorical interfaces, with undergraduate students rating the metaphorical interface as more appealing. Analyses regarding learning outcomes with respect to the three interface styles, however, yielded no significant differences between groups. These results suggest that visual aesthetics in interface design are not influential over learning outcomes. It is possible, however, that a lack of sufficient difference between the interface designs may have posed limiting effects on the study. The catch phrase in the title of the manuscript reads "Are Pretty Interfaces Worth the Time?" Yet one could argue that all three interfaces were actually attractive interfaces. Given this limitation, more research in this area is needed in order better understand the possible influences of interface visual aesthetics on learning.

In contrast with Cheon and Grant's (2009) findings, work by Um (2009) demonstrated that an educational website (about the immune system) whose interface visual aesthetics were manipulated to elicit positive versus neutral emotional responses from their viewers *did* have an effect on how well students learned with the site. With content information and website interface layout and functionality held constant, students assigned the 'positive emotion' interface design performed significantly better on assessments of post-knowledge and transfer than students using the educational website with the 'neutral' design. The neutral design utilized a monochromatic

gray scale; the positive emotion design built on the neutral design, infusing it with a warm palette of colors and anthropomorphic qualities by way of adding faces to various objects shown in the website. It should be noted, however, that the duration of the online lesson was just seven minutes—a relatively short amount of time that might detract from the study's external validity.

Through this study, Um (2009) demonstrated that educational websites whose interface designs were manipulated to elicit positive emotional responses from their viewers had a significantly positive effect such that, in addition to knowledge gain, measures of these viewers' affective states were found to be higher in positive affect than students viewing the alternate 'neutral' interface. These findings support Norman's (2004) assertion that attractive products "work better" by eliciting a state of positive affect, which has been linked with improved cognitive processing in terms of creativity, problem solving, and perseverance (Isen, 1993, 2001; Isen & Reeve, 2005; Kuhl & Kazen, 1999;).

2.7.4   The Pilot Study

Thus far research pertaining to interface visual aesthetics and impressions of educational computer-based media has tended to remain at a general level (e.g., good-bad; positive-negative; appealing-unappealing) with respect to judgments of preference and quality (Cheon & Grant, 2009; Lindgaard, et al, 2006; Schenkman & Jonssons, 2000; Skadberg & Kimmel, 2004; Um, 2009). The impressions people form, however, deal with more than simple dichotomies of evaluative thought. The current knowledge base in the area of interface aesthetics and learning outcomes does not yet reflect the complexity that lies beneath and beyond these more general aspects of impression formation. As mentioned earlier, "Watches tell more than time." Likewise, the visual information conveyed through computer interface design reflects a complexity that

speaks to much more than notions of 'good versus bad.' The pilot study (Manning, Lawless, & Mayall, 2001) for the current research addressed this complexity by capturing different kinds of perceptions students had as they formed their impressions of the impending task. It also examined how the appearance of a web-based lesson's interface, through the professionalism of its aesthetic design (professional vs. amateur), influenced learning outcomes.

The design consisted of two conditions under which 55 participants completed a web-based lesson about the role of DNA in genetics. Half of the participants received the Amateur version of the lesson whose interface was designed without the level of aesthetic treatment offered by the trained eye of a professional graphic designer; the other half received the Professional version of the same interface, which was aesthetically treated to meet the standards of professionally designed graphic media. The content information, layout, and functionality of both websites were held constant such that the only difference between the two was their level of professionalism in terms of visual aesthetics. The aesthetic treatments of the lesson's interface either departed from or conformed closely to visual principles of effective website design adopted by professionals in the field (e.g., use of color, alignment, font choice, white space; Beaird, 2007; Samara, 2007; Tidwell, 2005), yielding an Amateur-style and a Professional-style interface. Although the designs differed with respect to professional appearance, both styles were created to appeal visually to their intended viewership of undergraduate level pre-service teachers.

Pre-activity questionnaires were administered to all participants, with items pertaining to: (1) prior knowledge of the topic, and (2) initial impressions about the quality of the web-based lesson. After providing responses to the prior knowledge items, students were instructed to open their computer's Internet browser and type in the URL for the educational website (that

corresponded to the participant's randomly assigned experimental condition). Students were asked to remain on the home page of the website, using it to answer items in the questionnaire packet pertaining to their first impressions of the educational website (i.e., overall quality, enjoyableness, trustworthiness, interactivity, content information, and visual appeal). Once students finished filling out their responses, they used the website to learn about the role of DNA in genetics. Upon completion of their interactions with the educational website (~15-20 minutes), students were provided with a post-activity questionnaire that contained items pertaining to: (1) final impressions about the quality of the web-based lesson; (2) a post-assessment of topic knowledge; and (3) demographic information.

It was hypothesized that the visual cues embedded in the interface design for each of the two versions of the educational website would elicit different perceptions from their respective viewers about the quality of the impending instructional task and the educational experience likely to occur. Results showed that the Professional-style interface received significantly higher ratings than the Amateur-style interface in terms of perceived overall quality, content information, and trustworthiness. Findings were also supportive of the anchoring effect, for students' final impression ratings for educational website showed that, in spite of a movement in scores toward more similar ratings from both groups, ratings from each group remained biased toward students' initial impressions of the website activity.

This begs the question of whether examining the effects of impression formation is a worthy pursuit, given that the trend described above suggests an eventual convergence of scores as students spend more time interacting with the educational website. Why should students' initial impressions matter if this is the case? Even though their final ratings about the educational website's quality as an instructional tool exhibited an adjustment in judgment, the initial

impressions students formed about the educational website still managed to bring about long-term effects such that the students who used the Professional-style interface design performed significantly better on a post-assessment of knowledge than those who used the Amateur-style interface, even after controlling for prior knowledge. It appears that the phenomenon of the self-fulfilling prophecy (Merton, 1948) has been supported once again.

Furthermore, additional examination of the data revealed that the difference between the two groups was with respect to the more challenging deep level knowledge items as opposed to items measuring surface level knowledge. According to Jong and Ferguson-Hessler (1996), deep level knowledge is knowledge that has been processed and stored in such a way that it can be utilized for critical thinking, application, and performance. Surface level knowledge, on the other hand, is associated with rote learning and reproduction. The degree to which these different kinds of knowing are mastered by students provide additional means for uncovering the quality and gradations of knowledge that different individuals may possess regarding how well they have learned within a given topic or domain.

These distinctions are important to consider because they address students' depth of processing, discussed earlier in this chapter in terms of the Elaboration Likelihood Model (ELM; Petty & Cacioppo, 1986). It describes how the quality characteristics of the task as conveyed to learners by way of its delivery/presentation can affect the degree to which its content information is processed—or 'elaborated' upon—by the receiver. In terms of the expectancy-value theory of achievement motivation (Eccles et al, 1983; Eccles & Wigfield, 2002; Wigfield & Eccles, 2000), depth of processing and the development of deep versus surface levels of knowledge speak to students' achievement-related choices and academic performance with respect to a given task. Of particular interest in the present investigation is a better understanding of the motivational

components that lead to this point. How do different perceptions, expectancies, and task values characterize the nature of engagement and learning with a computer-based educational task?

Building onto the current literature base, the current research investigation takes the next steps in this area of study. The following sections outline its purpose and the questions it aims to answer.

2.8   Contributions of this Research

A consequence of learning in this digital age is the increasing prevalence of students embarking on computer-based educational tasks without the helpful interactions and guidance that human instructors would normally provide. Resultant outcomes produced from engagement with these computer-based tasks then rely solely on the student, what that student brings to bear in a given learning situation, and the implementation of the task itself. Under these circumstances, it would be wise to investigate in more detail the ways in which educational computer-based activities, which are often designed for stand-alone use, may be designed and implemented for more optimal learning experiences and outcomes.

This research explores the concept of the self-fulfilling prophesy (Merton, 1948) in the context of learning with digital media. Through the lens of expectancy-value theory (Eccles et al, 1983; Eccles & Wigfield, 2002; Wigfield & Eccles, 1992, 2000), this study investigates whether and in what ways students' initial impressions can influence the educational experience and resultant learning outcomes from engagement with an educational computer-based task. The first impression effect is examined in terms of two different channels that both lead to this phenomenon: (1) verbal (i.e., in the form of words, written or spoken) information provided to students about the quality of the educational resource and (2) interface visual aesthetics. The

moderating effect of student attributes on this process is also taken into account.

If the initial impressions of a computer-based task elicited by either of these two channels are shown to be influential in how well students learn with that task, then a better understanding of how to leverage those effects for more optimal educational experiences is in order.

2.9   Research Questions

This research investigation seeks to address the following questions, RQ1 and RQ2:

RQ1.1. Can students' 'impressions of an educational task' be measured in such a way that this construct is successfully operationalized with respect to the characteristics of the task that speak to its quality?

RQ1.2. What underlying dimensions might exist with respect to students' impressions of a computer-based educational task?

Addressing a gap in the existing literature base, this research investigation delves more deeply into the various perceptions/feelings students may have about the task through the development of a measure for 'first impressions of a task' and collecting data that sheds light on the makeup of this construct (e.g., perceived enjoyableness, trustworthiness, interactivity, etc.). This approach is unlike past work whose focus regarding perception/feelings about the task has remained at general levels of 'goodness' in terms of quality, going no further. This information would provide more insight into the kinds of thoughts and feelings people have when

encountering different digital tasks, allowing for a means through which to pinpoint the nature of the differences that exist in impression formation. Such information would prove useful for designers and creators of digital learning experiences whose work must connect effectively with the students that use it.

RQ2. After equating groups with respect to prior knowledge and individual interest in genetics, do interface visual aesthetics, verbal information pertaining to the quality of the educational task, or combinations of different conditions from both factors have an effect on:

RQ2.1 *students' first impressions of the task?*

RQ2.2 *their expectancies and how they value the task?*

RQ2.3 *their achievement-related choices with respect to the task?*

RQ2.4 *how well they learn with the task?*

A major goal of this research is to examine the ways in which the contextual elements of a given task may affect the learning experience. In particular, it focuses on the effects of (1) verbal information provided to students about the quality of the educational resource and (2) the interface's visual aesthetics. Although both of these first impression factors have been addressed in the literature to some extent, they are examined in the present study in ways not yet explored.

First, by addressing both together within the same study, this research reveals interaction effects that may exist between the two. It is hypothesized that exposing learners to favorable conditions from both factors will elevate students' achievement motivation and learning

outcomes more so than conditions that combine favorable with unfavorable. Regarding these

favorable-unfavorable combinations, it would be useful to know how and in what ways opposing

conditions may offset each other. Additionally, it is hypothesized that exposing learners to

unfavorable conditions from both factors will result in the lowest levels of achievement

motivation and learning outcomes from the task.

Second, this study examines the first impression effect with respect to the expectancy-

value theory of achievement motivation (Eccles et al, 1983; Wigfield & Eccles, 1992, 2000;

Eccles & Wigfield, 2002), which includes constructs that speak to achievement motivation such

as students' perceptions about the task, their expectancies relative to the task, as well as the ways

in which students place value on doing the task. Because this theoretical model aims to explain

why students would want to do a given task, it offers a perspective that goes hand-in-hand with

the goals and concerns of this research. Additionally, this investigation adds to the expectancy-

value literature base by applying this theory as part of experimental research, which has not yet

been done.

Third, students' depth of processing is addressed with respect to learning outcomes.

There is a scarcity of research that examines impression formation with respect to actual

measures of learning. This research investigation not only examines students' learning outcomes;

it examines them with respect to the quality of learning. To get a better sense of how effective

the educational task may have been in terms of its delivery and presentation (i.e., the different

channels leading to the first impression), this study examines learning outcomes with respect to

deep versus surface level processing. Students assigned to favorable conditions are hypothesized

to process the educational website's content information more deeply than students assigned to

unfavorable conditions, based on results from the pilot study for this research (Manning,

Lawless, & Mayall, 2011). In cases of favorable-unfavorable combinations, it would be useful to know whether and in what ways different conditions for each factor may offset the other. For example: will providing favorable verbal information to students about the quality characteristics of the task be enough to compensate for the poor visual aesthetics of an educational website?

Lastly, in addition to the design of the educational task, the learning process depends on the individual learner—and this research takes individual characteristics into account when examining for the possible effects that manipulations to the presentation of the task have on the learning process. As discussed earlier in this chapter, students with differing levels of prior knowledge and individual interest in a subject area tend to exhibit different behaviors and learning outcomes with respect to the computer-based task (Barab, Bowdish, & Lawless, 1997; Carmel, Crawford, & Chen, 1992; Dimopoulos & Asimakopoulos, 2010; Lawless & Kulikowich, 1996; Lawless, Schrader, & Mayall, 2007; Recker, 1994; Schrader, Lawless, & Mayall, 2008;). In conjunction with the examination of first impressions, expectancies, task values, achievement-related choices, and learning outcomes with respect to the experimental conditions of the task, this research acknowledges how differing levels of prior knowledge and individual interest might also influence these things.

2.10   Summary

This chapter served as a review of the relevant research in this area of inquiry. Likened to the notion of the self-fulfilling prophecy, the first impression effect was illustrated in educational settings and before being discussed as an instructional strategy in the design and implementation of computer-based educational tasks. Linked to the impressions students form about the task (i.e., perceptions/expectations), the task's contextual elements—which provide users with a

means through which to quickly evaluate quality characteristics of the task—have been shown to have some influence over students' motivation to engage and learn with the task.

The expectancy-value theory of achievement motivation (Eccles et al, 1983; Wigfield & Eccles, 1992, 2000; Eccles & Wigfield, 2002) provides a comprehensive framework for understanding the development of students' achievement motivation with respect to contextual aspects of the task. It is through this theoretical lens that this research examines the influence of task context on motivation and learning by way of two different channels leading to impression formation: (1) verbal information pertaining to the quality of the educational resource and (2) interface visual aesthetics.

CHAPTER 3

METHOD

3.1   Participants

Participants of this investigation were 196 undergraduate and graduate students (60

males, 136 females) from two universities—an urban midwestern university and a university

located in the pacific northwest. Students ranged from freshman-level undergraduates to graduate

students (1 freshman, 35 sophomores, 77 juniors, 49 seniors, 34 graduate-level). Participants

were recruited from teaching methods and technology-related pre-service education courses.

This academic span of students garners a sample with a broad range of knowledge with respect

to the educational content presented in the reseach activity, reflecting a range of academic goals

and interests that serve the purposes of this study. Additionally, this sample of students, whose

academic coursework revolves around the specifics of learning and instruction, provide a

perspective different from participants recruited for past related research (e.g., Cheon & Grant,

2009; Fries, Horz, & Haimerl, 2006; Um, 2009). Participants completed a task in which they

engaged with an educational website in order to learn about genetics. The research activity was

conducted as part of regular class instruction.

3.2   Design

This research sought to gain a greater understanding of the first impression effect by way

of the contextual factors that lead to impression formation. To address these goals, the research

design consists of six conditions produced by two factors: (1) verbal (written) information

pertaining to the quality of the educational resource (Favorable, Unfavorable, or Neutral) and (2)

interface visual aesthetics (Basic or Embellished) (see Table I). Although it would be possible to run the study without the 'Neutral Info' condition, it is included because: (1) it allows for comparison between the Basic and Embellished groups without the added influence of the other variable; and (2) this component of the research design is modeled after research by Fries, Hors, and Haimerl (2006) regarding the effect of verbal information pertaining to the quality of the task—can their results can be replicated under somewhat different circumstances?

Table I
Research Design

Treatment	Favorable Info	Unfavorable Info	Neutral Info
Basic Interface	Basic Interface Favorable Info	Basic Interface Unfavorable Info	Basic Interface Neutral Info
Embellished Interface	Embellished Interface Favorable Info	Embellished Interface Unfavorable Info	Embellished Interface Neutral Info

3.3   Materials

3.3.1   Task Instructions Plus Embedded Manipulation

Task instructions were provided to students prior to their use of the educational website. Students were informed that they were to prepare for a knowledge assessment covering information found in the site. The website was designed with three learning modules, displayed across the home screen (from left to right) in the following order: 'Classical Genetics,' 'Patterns of Inheritance,' and 'Modern Genetics & DNA.' As part of the instructions, students were also told that the knowledge assessment would only cover the first two of the three modules, naming each for good measure. This aspect of the task was designed as a means to capture one of the

outcome variables, a measure of how well students stayed 'on task' through the examination of navigational data with respect to the web pages students visited: task-relevant versus not relevant.

Three versions of the task instructions were created, each providing different information pertaining to the website's quality as an educational resource. By way of random assignment, approximately one-third of participants received information that is *Favorable*; approximately one-third of participants received information that is *Unfavorable*. The last third of participants functioned as the *Neutral* (control) group, receiving no information about the website's quality as an educational resource.

As previously mentioned, manipulations for this variable were modeled after the methods used by Fries, Horz, and Haimerl (2006) in their research examining the effect of student expectations on the quality of learning that occurred with an educational computer-based program, discussed in detail in Chapter 2. Embedded manipulations in the instructions for the task created three different conditions in the present research that closely paralleled conditions created by Fries and colleagues in their research: (1) the 'high-end' condition, in which participants are told that the program is a high-end product with positive reviews from a highly respected magazine, hailing it as a "best-practice prototype of future university education"; (2) the 'student project' condition, in which participants are told that the program is the result of a student project and in need of improvement; and (3) the neutral, or 'no expectations' condition, in which participants are not provided with any additional information regarding the program's quality.

Embedded manipulations in the present research were presented as follows:

FAVORABLE CONDITION: This educational website is last year's winner of the prestigious *Emerson Getty Award in Digital Learning* and was recently written up in *Performance Improvement* magazine as an exemplar of online instruction at the university level. Thus far, student ratings and feedback about this site have been highly favorable.

UNFAVORABLE CONDITION: This educational website was developed as a course project by two undergraduate students at UIC: a web design major and a biology major. Because it is currently still under development, it is possible you may come across some minor technical glitches and content-related errors. Information gathered about this site will be used to improve upon its design.

3.3.2   Educational Website

Two versions of the same educational website about genetics were administered to students (randomly assigned at the classroom level), each created to differ with respect to their graphic design treatments only (*basic* versus *embellished* interface visual aesthetics). The educational website covered three major topics in the area of genetics: classical (Mendelian) genetics (e.g., Punnett Square, genotype vs. phenotype), biological patterns of inheritance (e.g., sex linkage, blood types), and molecular genetics (e.g., DNA replication, protein synthesis). Each of these three topics consisted of five to eight sub-topics that students could navigate to and study. Each content page of the website also contained various media types such as images and interactive exercises, along with hypertext linking to other related content pages within the website.

In total, the site consisted of 18 pages of genetics web content (13 relevant, 5 not relevant) covering 3 learning modules, with students' site interaction times at approximately 30 minutes. This is in contrast to the version of the genetics website used in the pilot study, with

which students interacted for 15-20 minutes. The educational website content was an expansion of the genetics content used in the pilot study. The intention was to create a more robust learning situation requiring higher levels of engagement in terms of both time and interactivity, reflecting an instructional intervention that is more true-to-life than the shorter interventions utilized in past related research.

The content information, layout, and functionality of both versions of the website (*basic* and *embellished*) were held constant, for the intent was to isolate the visual aesthetic as part of participants' web-based learning experiences. To accomplish this, the website was constructed using hypertext markup language (HTML). The visual aesthetics, or design 'style,' was controlled by way of Cascading Style Sheets (CSS). CSS is a scripting language that controls the look and formatting of digital documents intended for virtual display and written in a markup language such as HTML. CSS is designed primarily to enable the separation of document content (written in HTML or a similar markup language) from document presentation, providing control over visual elements such as the layout, colors, fonts, and other graphical treatments.

Graphic design treatments of the website's interface were manipulated by two professional designers based on principles of visually appealing website design adopted by professionals in the field with respect to the site's particular purpose and the intended audience (e.g., use of color, value (lightness/darkness), alignment, font choice, curved/rounded lines that encourage directional flow of eye movement, graphical imagery, texture, contrast, shading/shadow, white space; Tidwell, 2005; Beaird, 2007; Samara, 2007), yielding one interface that displayed an *Embellished* graphic design treatment and one that retained a *Basic*, non-embellished design. The Embellished version of the interface was engineered to provide a rich visual experience, its graphical elements working together to compose an aesthetically

pleasing and valid design (given the subject matter, audience, and venue) aimed toward eliciting the types of favorable perceptions and feelings viewers might have with respect to an educational website about genetics (e.g., enjoyable, trustworthy, good quality content). The Basic version of the interface, in contrast, was not aesthetically engineered toward creating the 'right' impressions with respect to its users. Rather, its design remained free of the additional work called upon by the embellished interface, which was designed with impression management in mind. Designers' decisions regarding the Basic design were geared toward a simple and plain look that is uninspiring, yet does not violate principles of design in favor of 'deliberate ugliness' or poor visual communication. Figures 3, 3a, 4, and 4b below depict sample screenshots of the alternate versions of the website (basic vs. embellished) with respect to interface visual aesthetics.

Visual Aesthetic: Basic

Genetics
Inheritance & DNA

Welcome!

This website serves as an introduction to genetics concepts, focusing on three major topics in this fascinating subject area. Please select one of the short lessons from any of the three modules below to get started.

Classical Genetics	Patterns of Inheritance	Modern Genetics & DNA
Gregor Mendel	Sex Determination	The Structure of DNA
Punnett Square	Intro to Blood Types	Reading the DNA
Law of Dominance	Blood Type & Multiple Alleles	DNA Replication
Law of Segregation	Sex Linkage	Protein Synthesis
Law of Independent Assortment	Environmental Influences	Mutations
Doing a Test Cross		
Incomplete Dominance		
Codominance		

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Figure 3

Figure 3a

Visual Aesthetic: Embellished

Figure 4
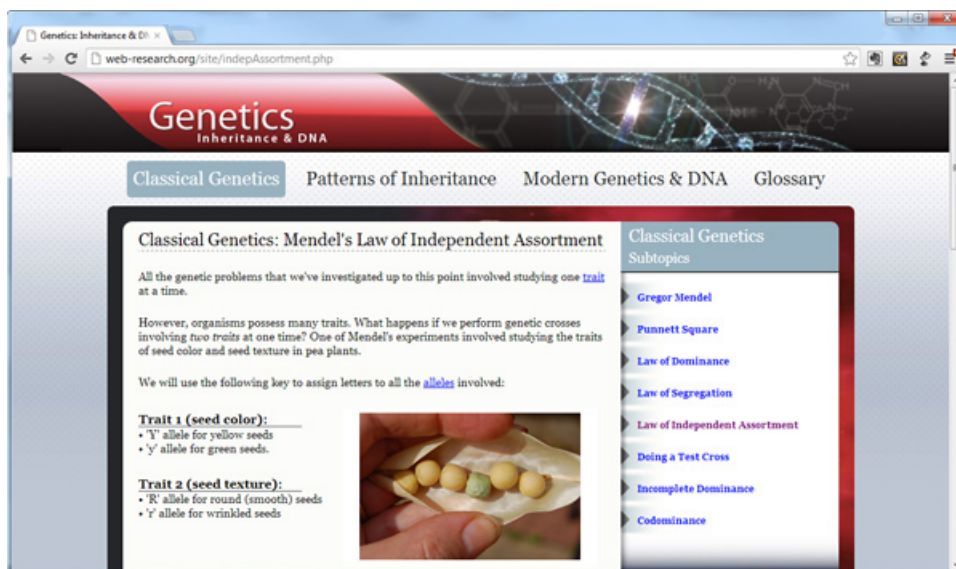
Figure 4a

3.4   Instrumentation

This section provides the reader with information about the instruments that were utilized in the investigation, summarized below in Table II. More detailed descriptions of each measure are supplied in the paragraphs following this table.

Table II

Instrumentation Summary Chart

Name of Scale / Construct Measured		#Items	Response Format	Administered	Time
Individual Interest	Individual Interest at the domain level: genetics	14	6-point Likert-type rating scale	Pre-activity	2 min
Prior Knowledge	Knowledge assessment; prior knowledge at the domain level: genetics	13	Multiple choice	Pre-activity	8 min
Impressions of the Task	Perceptions/Expectations pertaining to task quality characteristics (First and Final impressions)	11	6-point Likert-type rating scale	Pre-activity Post-activity	2 min
Expectancies for the Task	Student expectations for success on the task	3	7-point rating scale	Pre-activity	1 min
Task Values	The ways that students value doing the task: intrinsic, attainment, utility, and cost	11	7-point rating scale	Pre-activity	2 min
Topic Knowledge	Knowledge assessment; Knowledge of the educational topic areas covered in the website after instructional intervention	13	Multiple choice	Post-activity	12 min
Point of Comparison Check	A check for internal validity; the determination of whether students perceive the two visual aesthetic conditions differently (as intended)	4	7-point rating scale	Post-activity	1 min
Demographics	Participants' demographic information	6	Multiple choice; Check all that apply	Post-activity	2 min

3.4.1   Individual Interest

The construct of individual interest was measured using a scale adapted from Schiefele and colleagues' (1993) Study Interest Questionnaire (SIQ). This measure was developed to assess academic interests of college students at the domain level. Because items in the SIQ are worded with respect to students' college "major," adjustments have been made so that they reflect interest in the domain of 'genetics'. The 14-item, adapted version of the SIQ can be found in Appendix A.

Affective, value-oriented, and intrinsic valence aspects of interest are measured in the SIQ, which in certain respects are complementary to various aspects of expectancy-value theory (Eccles et al, 1983; Wigfield & Eccles, 1992, 2000; Eccles & Wigfield, 2002). The affective valence consists of items that evaluate how doing work in this area makes the participant feel; the value portion assesses students' beliefs about the importance of doing work in this area of study; and the intrinsic valence corresponds with students' inherent enjoyment of engaging in work in this area. Although this measure was designed for high internal consistency, these valences are remain conceptually distinct and do not separate out into different factors (Schiefele, 2009; Wigfield & Cambria, 2010). Reliability estimates for both the original and revised versions of the SIQ as developed by Schiefele and colleagues were very high, yielding a Cronbach's alpha coefficient of .93 and .90, respectively. Data from the present research yielded a Cronbach's alpha coefficient of .93.

3.4.2 Prior knowledge

Instrumentation measuring students' prior knowledge in the domain of genetics was adopted from research conducted by Lawless, Schrader, and Mayall (2007) that examined the effect of higher and lower levels of prior knowledge on knowledge gain when learning with an educational website. In the present research, this measure was examined as both a covariate and as a moderating factor in the learning process. The choice to utilize a measure of knowledge at the *domain level* was guided by results from the relevant literature (discussed in Chapter 2; Alexander, Kulichowich, & Schultz, 1994), which indicate that domain-level knowledge is a better predictor of recall in a topic area than topic knowledge. Genetics knowledge at the domain level is captured in a 13-item multiple choice assessment of knowledge that covers a wide range of genetics topics such as genetic engineering, human reproduction, heredity, and molecular function. This instrument (see Appendix B) was reviewed for content validity by a medical doctor with an expertise in genetics and two educational psychologists with experience in the development of online learning materials. Two reliability estimates performed on this measure with different student samples both yielded sufficiently high results (Cronbach's alpha > .7). A KR-20 reliability analysis based on the data from this investigation, however, produced a Cronbach's alpha coefficient of .40, scoring below the range of what is considered an 'acceptable' reliability measure. It is possible that this sample was not heterogeneous enough to provide the variance needed for a more optimal score. In any case, results with respect to this construct should therefore be viewed with caution.

3.4.3 Impressions of the Task

Impressions of the Task items were developed to reflect the wide variety of perceptions

that likely contribute to the impressions students may form regarding the particular task (e.g.,

trustworthy, effective, interactive, enjoyable). Due to wording issues with respect to pre- and

post-activity impressions (anticipatory and past tense), slight adjustments were made to the items

in order to reflect proper verbiage for the time of administration. Items conformed to a 6-point

Likert-type scale, with rating options ranging from highly disagree to highly agree. The majority

of the items were adopted from the pilot study (Manning, Lawless, & Mayall, 2011) in which the

9-item scale exhibited good internal consistency, yielding a Cronbach's alpha coefficient of .81.

As part of this study, new items were added that served to address research concerns of interest

as described in the related literature (Eccles & Wigfield, 1995; Manning & Lawless, 2011) and

discussed in Chapter 2. These items reflect perceived difficulty of the task and its perceived

novelty (i.e., up-to-date vs. outdated). The updated 11-item instrument is located in Appendix C.

This newly developed scale yielded a Cronbach's alpha coefficient of .91, indicating high

internal validity.

3.4.4 Expectancies for the Task and Task Values

Items addressing both *expectancies* and *values* for the given task have been developed

based on measures utilized in two examples of past work on the expectancy-value theory of

achievement motivation (Eccles & Wigfield, 1995; Selkirk, Bouchey, & Eccles, 2011). These

two studies were specifically chosen because they dealt with adolescents (ranging from grades 5

through 12) versus younger children. (As mentioned in Chapter 2, Eccles, Wigfield, and

colleagues have focused their research efforts on examining the development of expectancies and

values in *children*—as opposed to adult participants.) The items employed in these studies therefore reflect wording that is more appropriate for older children and adults. This includes the adult students who were recruited for this study.

The *expectancy*-related items utilized in both studies exhibited acceptably high internal reliability (Cronbach's alpha = .91 in the domain of mathematics; Cronbach's alpha = .87 in the domain of English). Because the present research deals with a not only a different area of study (genetics), but also examines the task at the 'micro' (specific task) level versus the 'macro' (domain) level of study, it was necessary to modify the items as utilized by Eccles and Wigfield (1995) and Selkirk and colleagues (2011) in order to better meet the needs of the present research. This modified 3-item, 7-point rating scale measure is available for viewing in Appendix D and yielded a Cronbach's alpha coefficient of .80 in this research.

Reliability estimates for *task value*-related items from both studies (Eccles & Wigfield, 1995; Selkirk, Bouchey, & Eccles, 2011) were obtained as follows. Eccles and Wigfield chose to examine the three positively-valanced dimensions of task value with respect to math: attainment, intrinsic, and utility values. The cost dimension of task value was not included as part of this research. Measures consisted of two to three items per task value dimension with a 7-point rating scale response format. Cronbach's alpha coefficients for items measuring attainment and intrinsic value were acceptably high: .70 and .76, respectively. Items measuring utility value were not of sufficiently high value, however. In work by Selkirk and colleagues (2011), items measuring the utility and attainment dimensions of task value were grouped together, reflecting good internal reliability (Cronbach's alpha = .83 in the domain of math; Cronbach's alpha = .86 in the domain of English). Reliability estimates for the intrinsic dimension of task values were examined separately, also yielding sufficiently high values (Cronbach's alpha = .87 in the

domain of math; Cronbach's alpha = .75 in the domain of English). Additionally, Selkirk and colleagues collected data reflecting the cost dimension, specifically in terms of test anxiety. These items exhibited very good internal reliability (Cronbach's alpha = .87 in the domain of math; Cronbach's alpha = .90 in the domain of English).

Issues surrounding the design of items reflecting task values for this study are similar to those expressed regarding expectancy-related items: this research (1) deals with a different area of study (genetics) and (2) examines the task at the 'micro' (specific task) level versus the 'macro' (domain) level of study. Therefore, like the expectancy-related items, the task value-related items were also modified in order to meet the needs of this research investigation. Guided by the related literature, this modified instrument was designed to capture *all four* dimensions of students' subjective task values (intrinsic, utility, attainment and cost) and is also located in Appendix D. Cronbach's alpha coefficients for each are as follows: intrinsic value = .95; utility value = .78; attainment value = .86; cost = .78.

3.4.5   Topic knowledge

Instrumentation pertaining to genetics knowledge with respect to the educational website's content functioned as a post-activity assessment of how well students learned. The multiple choice items were also labeled as to whether they address surface level or deep level knowledge of the genetics material because results from the pilot study (Manning, Lawless, & Mayall, 2011) indicated that significant differences in how well students learned were in terms of their deep level knowledge of the topic (but not surface level). The topic knowledge items used in this assessment tool, along with the content information for the website, were adapted from a *Cliffs Study Solver* self-study text covering the typical high school biology curriculum from the

popular *Cliffs Notes* collection of study guides (Rechtman, 2004). This 13-item multiple choice

knowledge assessment in can be found in Appendix E. A KR-20 test of reliability for *Topic*

Knowledge using data from the present research yielded a Cronbach's alpha coefficient of .63,

which is considered questionable regarding internal consistency and ought to be taken into

consideration by the reader.

3.4.6   Point of Comparison Check

One threat of internal validity lies in the aesthetic designs of the website interface in that

there is the possibility that not all participants will perceive the designs as intended by the

designer due to the subjective nature of visual communication and preferences regarding graphic

art. This issue was addressed by obtaining ratings from participants post-activity: participants

were also exposed to the aesthetic version of the educational website to which they were *not*

assigned. Seeing both sites side-by-side provided participants with a point of comparison as they

rated each design with respect to perceived visual appeal and professionalism.

3.4.7   Demographic Items

Demographic items collected information regarding participants': university status/year

(e.g., sophomore, junior), major and minor areas of study at the university, pre-service subject

matter concentration, gender, and past experience with respect to science and genetics-related

learning experiences.

3.5   **Procedure**

This section outlines the procedures involved in gathering data for this research

investigation. It is recommended that the reader refer back to Table 2 as the different instruments

administered in this research are mentioned throughout the paragraphs that follow.

Participants first received a brief introduction to the research activity, at which time they

were informed that they would be engaging with a science task. Post introduction, all aspects of

the research activity (i.e., the task and collected measures) were computer-based. First, measures

pertaining to students' individual interest and prior knowledge in the domain of genetics were

administered. After completing these initial measures, participants then received instructions for

the educational task. The instructions differed slightly with respect to the condition to which

participants had been randomly assigned. It was in the instructions where students received

information about the impending task that was Favorable, Unfavorable, or Neutral quality (no

additional information received).

After reviewing the instructions, participants were then presented with three screenshots

from an educational website on genetics (with a Basic or Embellished interface design, randomly

assigned at the whole-classroom level). Based on the screenshots they saw, participants

completed items reflecting their first impressions of the task, expectancies for the task, and how

they valued the task.

After completing these measures, participants then engaged with the actual educational

website, using it to learn about genetics in preparation for a post-test of knowledge on the topic.

Once they finished using the educational website to learn about genetics, students

answered items pertaining to their post-activity impressions of the task. Next, the assessment of

topic knowledge was administered. Once these were completed, participants viewed both

aesthetic versions of the educational website's interface design and completed the Point of

Comparison Check items. Participants completed demographics items last. When finished, all

participants received a debriefing about the research activity, during which they were also

advised not to discuss the content of their sessions with other potential study participants.

CHAPTER 4

ANALYSIS and RESULTS

This chapter describes the data analytic methods applied toward evaluation of the

research questions for this investigation, utilizing IBM's Statistical Package for the Social

Sciences (SPSS). First data screening techniques and preliminary analyses are discussed,

followed by a description of the statistical techniques deemed appropriate for the particular

concerns and interests of this research. Results of the analyses yield information that provides a

greater understanding of how the manipulation of certain contextual aspects of the learning

situation may bring about a first impression effect regarding the educational experience and its

outcomes. These statistical analyses and their results are explicated with respect to each of the

four research questions put forth by this investigation.

4.1   Data Screening and Preliminary Analyses

Prior to analyses addressing the particular questions posed by this research, the data

(which were already de-identified at the time of collection) were examined and screened for

accuracy, missing data, and the presence of univariate and multivariate outliers, which are

aberrant or extreme scores within one or more distributions that could bias statistics such as the

mean (King & Minium, 2008). In the instance that any outliers (univariate or multivariate) are

identified, further examination is necessary in order to understand *why* they exist before making

decisions about how best to deal with them.

Whereas univariate outliers represent cases with an extreme value on one variable,

multivariate outliers represent cases with an unexpectedly abnormal *combination* of scores on

two or more variables (Tabachnick & Fidell, 2007). For collected measures that reflect continuous variables, detection of potential univariate outliers can be performed by examining the standardized scores (z-scores) for cases that exceed 3.29, $p < .001$, two-tailed (Tabachnick & Fidell, 2007). For dichotomous measures, detection of univariate outliers can be conducted by examining frequency distributions for unusual observations relative to the cases. Dealing with such outliers—depending on the situation—could involve deleting the case in question, transforming the data, or even changing the score (under the appropriate circumstances). If transformation of the data is deemed the solution, the transformation must occur before examining the data for multivariate outliers. This is because the technique used to detect multivariate outliers (Mahalanobis distance) is sensitive to non-normality (Tabachnick & Fidell, 2007). Techniques used to reduce the influence of multivariate outliers are similar to those for univariate outliers. It should be noted, however, that the strategies of transformation and altering scores for specific cases may not be that effective because, by definition, the problem lies with an unusual *combination* of scores for a given case. In other words, the scores in question may not appear to be problematic on their own. If the data still yield outlier cases after changing scores and/or applying transformations, then those cases are usually deleted (Tabachnick & Fidell, 2007).

Checks for univariate outliers were conducted through the examination of histogram and boxplot output. Scores that IBM SPSS considered to be outliers were indicated along with case ID numbers, with extreme points flagged with an asterisk. Asterisked scores were removed from the data where it made sense to do so, after consulting the Extreme Values table. Other scores indicated as outliers were scrutinized in more detail: along with consideration with respect to the *why* of the outlying score(s), information from the Descriptives table of the output was consulted

with respect to the 5% Trimmed Mean values in comparison with the Mean values to determine whether the presence of outlier(s) affected the distribution of scores. If the two means were close in value, then the data in question was retained. Next, checks for multivariate outliers were conducted with respect to the analyses for this investigation. Malhalanobis distances were obtained for each grouping of dependent variables. For each, maximum values from the output were compared against the critical value table for evaluating Malhalanobis distances (Pearson & Hartley, 1958). In all instances, the critical value was not exceeded, indicating that there were no substantial multivariate outliers in the data. (Should the critical value have been exceeded, further examination of the data would need to occur with respect to Malhalanobis distances of individual cases.)

Given the chosen statistical techniques to be applied in response to the questions posed by this study, certain limitations/assumptions were addressed as part of the preliminary analyses to ensure the viability of these procedures. The following paragraphs discuss issues of multivariate normality, linearity, as well as multicollinearity and singularity.

Multivariate normality refers to the assumption that each variable within a study, along with all linear combinations of those variables, are normally distributed (Tabachnick & Fidell, 2007). Normality can be assessed both graphically and statistically. Variables displaying a normal distribution are represented by a symmetrical, bell-shaped curve (Field, 2009). Statistically, normality can be determined by examining the distribution with respect to skewness and kurtosis, where skewness refers specifically to the symmetry of the distribution and kurtosis refers to the peakedness of its shape (Tabachnick & Fidell, 2007). A perfectly normal distribution will yield skewness and kurtosis indices of zero; the further the values are from zero, the more likely it is that the data are not normally distributed (Field, 2009). Although there is no

easy way to test for multivariate normality, assessing skewness and kurtosis indices with respect to their z-score conversions allows some means for comparison between distributions regarding different variables being addressed within the study. One test of significance that may be used for both indices is to subtract the mean from the skewness or kurtosis value, then divide by the standard deviation of the distribution. If the absolute value of the resulting statistic is greater than 1.96 ($p < .05$), then that distribution exhibits significant skewness or kurtosis (Field, 2009).

It should be noted, however, that tests of significance for skewness and kurtosis (such as the technique above) tend to be less effective with larger sample sizes (approaching 200+) due to smaller standard errors. Therefore with larger samples it is recommended that the criterion measure be increased or that more emphasis be placed on the visual display of the distribution and on the value of the individual statistics for a distribution's skewness and kurtosis (Tabachnick & Fidell, 2007; Field, 2009). Given the sample size for this investigation (196 participants), Histogram and Normal Q-Q plots were examined. Conformance to a bell-shaped curve for the Histogram and the plotting of points along a reasonably straight line for the Normal Q-Q plot are visual indicators that suggest a normal distribution of the data. Based on these criteria, all variables met the specifications of normality. In addition, an inspection of skewness and kurtosis indices for all variables yielded relatively near-zero values of |.705| and less.

Being that the inferential statistics to be applied utilize a general linear model, it should be determined whether the assumption of linearity—that the relationship between two variables (or combinations of variables) can be represented with a straight line—has been met. Linearity between two variables can be diagnosed through the examination of bivariate scatterplots. If the variables are both normally distributed and exhibit a linear relationship, the scatterplot will display an ovular shape. If it appears that the assumption of linearity has not been sufficiently

met, then transformations or recoding of variables may be considered in order to enhance linearity (Tabachnick & Fidell, 2007). In the case of the current investigation, the assumption of linearity as examined between pairings of variables was met.

Because this research examines the effect of multiple predictors on an outcome measure, multicollinearity between predictors should also be considered. Multicollinearity becomes an issue when there exists a very strong correlation (.90 or more) between two or more predictors in a model (Tabachnick & Fidell, 2007). A more extreme example of this is the occurrence of singularity, where the relationship yields a perfect correlation. In such an instance the variables in question are completely redundant. The assumption of absence of multicollinearity and singularity should be met so that the contribution of individual variables toward a given outcome measure can be determined more clearly by the analysis. In addition to correlational values between variables, which were met regarding the variables in this investigation (r < .90), the assumption of no multicollinearity may be examined by way of the VIF and tolerance statistics provided through SPSS output. A VIF greater than 10, for instance, is cause for concern; a tolerance statistic below 0.2 indicates a potential problem, while a statistic below 0.1 is indicative of a serious problem. An examination of these two multicollinearity statistics yielded results well within the acceptable range.

4.2   Analyses Addressing Research Question 1

4.2.1   Research Question 1.1

RQ1.1. Can students' 'impressions of an educational task' be

measured in such a way that this construct is successfully

operationalized with respect to the characteristics of the task that

speak to its quality?

Regarding the measurement of students' impressions of the task, this investigation sought

to add to the current literature by going beyond mere levels of 'goodness' (Cheon & Grant, 2009;

Lindgaard, et al, 2006; Norman, 2004; Schenkman & Jonssons, 2000; Skadberg & Kimmel,

2004; Um, 2009) and digging deeper into what kinds of perceptions about a task actually make

up said 'goodness.' The measurement of this construct as part of this research necessitated the

development of a new scale that would capture a more nuanced picture of *Impressions of a Task*

(See Appendix C). This 11-item scale was created to reflect various quality characteristics likely

to contribute to an overall impression. Analyses regarding the viability of this scale regarding its

ability to measure the intended construct (i.e., reliability and validity) are discussed in the

following paragraphs.

As revealed in Chapter 3, results showed that the *Impressions of the Task* scale displayed

a high level of internal consistency, with a Cronbach alpha coefficient of .91. This far exceeds

the 'acceptable' minimum of .70 and lies within the 'excellent' range of >.90 (George &

Mallery, 2003). Item means and standard deviations are listed in Table III, below. Such a result

is an indication that this instrument was indeed successful in capturing the different contextual

nuances that together speak to the different ways a task's overall 'quality' or 'goodness' may be

evaluated by learners, contributing to the impressions they form about the task.

Table III
Means and Standard Deviations for 'Impressions of the Task' Items

Item	M	SD
(1) Good quality website	3.53	1.06
(2) Enjoyable	2.68	1.37
(3) Effective at helping me learn	3.67	.91
(4) Trustworthy	3.41	1.09
(5) Work really hard (effort exerted)	2.83	1.22
(6) Interactive	2.62	1.39
(7) Difficult to learn with	3.08	1.11
(8) Good quality content	3.63	.74
(9) Outdated	2.58	1.66
(10) Understandable presentation of info	3.46	1.02
(11) Attractive	2.43	1.60

Note. For all items $n = 196$. Items 5, 7, and 9 were negatively worded and then reverse-coded such that the higher the value, the more favorable the score.

Although a scale such as this might exhibit good reliability, it is not useful unless it also measures the construct is intended to measure: *Impressions of the Task*. To assess the construct validity of this scale, one must consider the nature of the construct. Scales measuring a construct are theorized to yield differences in scoring based on the given situation and/or the characteristics of individuals to whom the scale is administered. If scores differ in ways that align with how one would expect the construct to differ given changes in the situation/individuals, then the validity of the scale is supported. The validity of the *Impressions of the Task* scale will be demonstrated with respect to 3 different hypotheses:

Hypothesis 1.

Impressions of the Task will differ with respect to the interface

design such that scores for students presented with the Embellished

design are higher than scores for students presented with the Basic

design. Rationale: The Embellished version of the interface was

specifically designed to elicit more favorable perceptions from

students, while the Basic design was engineered toward a more

neutral, lackluster response.

Hypothesis 2.

After using the Basic version of the website to learn about

genetics, post-activity *Impressions of the Task* will yield scores

that are higher than pre-activity *Impressions of the task*. Rationale:

Interacting and learning with the website fostered more favorable

attitudes in students as their perceptions of the website grew more

'accurate' due to actual experience with the site. (Anchoring effect:

Tversky & Kahneman, 1974)

Hypothesis 3.

After using the Embellished version of the website to learn about

genetics, post-activity Impressions of the Task will yield scores

that are lower than pre-activity *Impressions of the Task*. Rationale:

Interacting and learning with the website fostered less favorable

attitudes in students as their perceptions of the website grew more

'accurate' due to actual experience with the site. (Anchoring effect:

Tversky & Kahneman, 1974)

To address Hypothesis 1, an independent samples t-test was conducted. Aesthetic design was entered as the independent variable (Basic versus Embellished), and scores representing students' *Impressions of the Task* prior to engagement with the website were entered as the dependent variable. A significant difference was found between groups such that scores for students shown the Embellished design ($M = 40.62$, $SD = 5.72$) were significantly higher than scores for students using the Basic design ($M = 27.86$, $SD = 8.75$); $t(177.28) = -12.19$, $p < .001$ (2-tailed). In other words, students presented with the Embellished design had significantly more favorable *Impressions of the Task* than students presented with the Basic design. This result is in support of the hypothesis.

To address Hypotheses 2 and 3, a paired samples t-test was conducted for each of the two aesthetic design groups: Basic and Embellished. The test compared students' pre-activity and post-activity scores for *Impressions of the Task*. Results are summarized in Table IV, below. Regarding the Basic design group, a significant difference was found between pre- and post-activity scores where students' post-activity Impressions of the Task were significantly higher than their pre-activity scores. The Embellished design group exhibited the opposite pattern: students' post-activity Impressions of the Task were significantly lower than their pre-activity scores. Results from both of these analyses are in support of Hypotheses 2 and 3.

Table IV
Differences in Students' Impressions of the Task Before and After the Educational Task

| Group | Pre-Activity | | Post-Activity | | | |
	M	*SD*	*M*	*SD*	*df*	*t*
Basic	27.86	8.75	32.12	8.65	102	-5.28***
Embellished	40.62	5.72	39.45	7.10	92	2.53*

p < .05. ***p* < .001. (2-tailed.)

In the case of all three hypotheses, scores for the *Impressions of the Task* scale differed in ways that aligned with the sorts of changes one would expect to see regarding the construct, in terms of both the situation (receiving a Basic versus an Embellished educational website to work with) *and* the individuals involved (students before versus after working with the website, Basic and Embellished groups). These results demonstrate construct validity with respect to this scale.

4.2.2 Research Question 1.2

RQ1.2. What underlying dimensions might exist with respect to students' impressions of a computer-based educational task?

Although the *Impressions of the Task* scale exhibits good reliability and validity, the items themselves do reflect a good deal of variety with respect to how learners assess an upcoming task. In fact, the items were specifically developed to capture the many different influential elements found in a given situation that may serve to contribute to impression

formation regarding the task at hand. This leads one to wonder about the existence of sub-dimensions of students' impressions of the task. Learning what these sub-dimensions are would shed additional light on just what constitutes a good first impression, providing educators and designers with information they can use to create more optimal lessons and learning environments.

To this end, exploratory factor analysis (EFA) was the statistical method of choice. Use of EFA is appropriate when one seeks to determine whether a series of factors, or dimensions, exist in the data and whether these dimensions can be explained and understood from a theoretical standpoint. EFA is also appropriate when dealing scale construction, where ascertaining the uni-dimensionality or multi-dimensionality of items measuring a given construct is desirable in order to gain a better understanding of the scale itself—what it is actually measuring (and where to go from there). EFA can be used to determine whether one or more dimensions exist among a set of variables.

Often times, the use of principle components analysis (PCA) is used interchangeably with EFA, but the two are not the same—mathematically nor theoretically. The goal of PCA is to reduce the measured variables into a smaller set of items that captures as much information in as few factors as possible. Unlike EFA, PCA results speak to the particular sample of participants and are not generalizable to the larger population. Additionally, because a major goal of EFA is to uncover common factors, it accounts for shared variance among the variables, making it more suitable for discovery and examination of underlying theoretical constructs—an important distinction from PCA (Hooper, D., 2012).

To assess the dimensionality of data as measured by the *Impressions of the Task* scale, 11 items were subjected to principal axis factoring. Factor analysis is generally a large sample size

technique, as correlations are less reliable with use of smaller-sized samples. Recommendations

for appropriate sample sizes tend to vary (Fabrigar et al., 1999), though according to Tabachnick

and Fidell (2007), sample sizes of 150 are usually sufficient (*Note:* the sample size for this

investigation is 196). IBM SPSS also includes measures to evaluate the appropriateness of

sample size as part of the analysis. The Kaier-Meyer-Olkin Measure of Sampling reading was

.894, which is well above the acceptable threashold of .6 (Kaiser, 1974), indicating a more than

adequate sample size to conduct an EFA. In addition, Bartlett's test of sphericity reached

statistical significance (< .05), meeting the criterion for this procedure by indicating sufficiently

large correlations between variables for the analysis.

Three factors were extracted, explaining 75.8% of the variance and exceeding the

minimum 60% threshold, as suggested by Hair and colleagues (2006). These factors were

decided upon, based on the cumulative variance values, eigenvalues, and inspection of the scree

plot. Three factors met Kaiser's eigenvalues greater than 1 criterion, observed at values of 6.09,

1.21, and 1.03, respectively (Fabrigar et al., 1999). Subsequent values displayed a clear drop,

with readings at .553 and below. Examination of the scree plot, which graphically represents

eigenvalues as a line with points plotted in descending order, also appeared to support a 3-factor

extraction, where the last significant break point at the elbow is shown to occur after the third

factor, before flattening out (see Fig. 5, below).
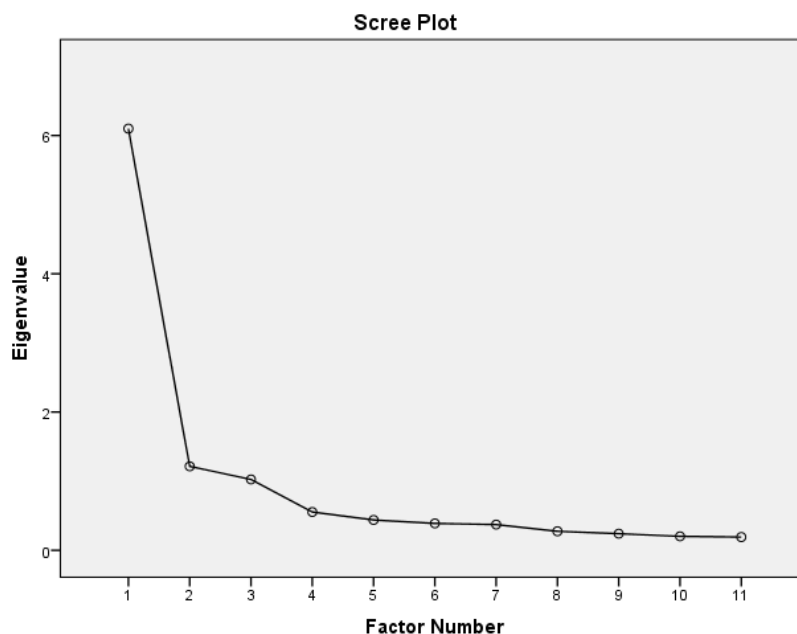
Figure 5

Because they were theorized to correlate with one another, factors were obliquely rotated and analyzed using both Promax and Direct Oblimin rotations, which allows for correlation between factors, versus an orthogonal rotation technique such as Varimax. Both rotational methods yielded the same results. Factor loadings are displayed in Table V, below. In examining the matrix, it is possible that an item may load heavily onto more than one dimension, or that it may not load onto a factor at all. Either of these results suggests a poor or unreliable item that may require deletion from the scale. In this case, however, each item loads on just one of the 3 dimensions, providing a clean solution for interpretation.

Interpretation of the three factors involves consulting the factor loadings per each item, which have been listed in descending order and can be used to help identify the nature of the underlying latent variables that have resulted from this analysis. Variables loading onto Factor 1 appear to represent impression formation pertaining to the social experience of task; variables loading on to Factor 2 appear to represent impression formation regarding task quality in terms

of caliber; lastly, variables loading onto Factor 3 seem to encapsulate what Eccles and Wigfield

(2002) have described as task demands. These sub-dimensions of students' impressions make

sense from a theoretical perspective, providing further support for the decision to retain all three.

Table V
Factor Loadings based on Exploratory Factor Analysis with Direct Oblimin Rotations for
11 Items from the Impressions of the Task Scale

Item		Social Experience	Caliber	Demands on Learner
11)	Attractive	1.043		
9)	Outdated	.816		
2)	Enjoyable	.732		
6)	Interactive	.638		
8)	Quality content info		.890	
3)	Effective at helping me learn		.859	
4)	Trustworthy		.759	
1)	Good quality website		.618	
7)	Difficult to learn with			.899
5)	Work really hard			.692
10)	Understandable presentation of info			.452

For exploratory factor analysis, however, it is a best practice to 'explore' all likely

options. Because the third factor displayed an eigenvalue so close to the criterion value of 1 and

contributed just under 10% of the variance, the possibility of a two-factor solution was also

examined. Results, however, were not as clean, and the 'meaning' of each of the factors was not

as clear as that derived from the three-factor solution. These results provided additional support

for the extraction of three factors.

In summation, results from the exploratory factor analysis has yielded three underlying

dimensions regarding students' impressions of the task: the social experience of the task, the

caliber of the task, and the demands placed on the student when engaging with the task (each

accounting for 55.4%, 11.0%, and 9.3% of the variance, respectively).

Because the EFA yielded these three underlying dimensions, it is important that the

reliability of these measures be checked to ensure their internal consistency as sub-scales to the

Impressions of the Task scale. Cronbach's alpha coefficients for all three sub-scales indicated

reliability levels well within the desirable range of above .70, with .89 for *Social Experience*; .87

for *Caliber*, and .78 for *Demands on Learner*.

4.3   Analyses Addressing Research Question 2

RQ2. After equating groups with respect to prior knowledge and

individual interest in genetics, do interface visual aesthetics, verbal

information pertaining to the quality of the educational task, or

combinations of different conditions from both factors have an

effect on:

RQ2.1 *students' first impressions of the task?*

RQ2.2 *their expectancies and how they value the task?*

RQ2.3 *their achievement-related choices with respect to the task?*

RQ2.4 *how well they learn with the task?*

To address this three-part question, factorial ANCOVA and factorial MANCOVA

techniques were applied. These techniques provide the researcher with the ability to partial out

the moderating effects of student characteristics, such as prior knowledge and interest, essentially

equating participants on these measures in order to better ascertain whether manipulating

different contextual aspects of the learning situation has a significant effect over: (RQ2.1)

students' initial impressions of the task; (RQ2.2) their expectancies and how they value the task,

based on the expectancy-value theory of achievement motivation (Eccles et al., 1983; Wigfield

& Eccles, 2000; Eccles & Wigfield, 2002); (RQ2.3) their achievement-related choices with

respect to the task, and (RQ2.4) how well students learned with the task.

Building upon elements of the ANOVA test, which determines whether mean differences

among groups are likely to have occurred by chance—given a *single dependent variable*, a

factorial MANOVA test examines mean differences among groups with respect to a *combination

of dependent variables* (Tabachnick & Fidell, 2007). This is done in the analysis through the

creation of a new dependent variable that represents the linear combination of all measured

dependent variables for each main effect and interaction. ANOVA is then conducted with respect

to the new dependent variable (Tabachnick & Fidell, 2007). However, the analyses performed

for this investigation were ANCOVA and MANCOVA. ANCOVA is also an extension of

ANOVA, where main effects and interactions are assessed after scores for the dependent variable

have been adjusted for differences associated with one or more covariates, which have been

theorized to be influential over the outcome measure. MANCOVA is simply the multivariate

extension of ANCOVA (Tabachnick & Fidell, 2007).

In addition to the assumptions previously described, factorial ANCOVA/MANCOVA

analyses require consideration of unequal sample sizes and homoscedasticity. Cells with unequal

n, for instance, bring about ambiguity regarding the interpretation of the means of each cell in

that the design becomes non-orthogonal. This means that the statistics in this situation do not

vary independently of each other (as is the case with orthogonality), and thus tests for main

effects and interactions are no longer independent (Tabachnick & Fidell, 2007). Should

equalizing cell sizes by way of deletion of random cases be undesirable, there are other strategies for dealing with this issue. For experimental designs such as that of the proposed research, SPSS actually adjusts for unequal cell sizes in its default settings for both univariate and multivariate analyses.

Homoscedasticity is the assumption that the variability of scores is roughly the same with respect to all (continuous) variables involved and is related to the assumption of normality (Tabachnick & Fidell, 2007). When dealing with discrete variables, or grouped data, as is the case with the proposed study, this translates into the assumption of homogeneity of variance for univariate statistics and the assumption of homogeneity of variance-covariance matrices when dealing with multivariate statistics (Tabachnick & Fidell, 2007). For univariate analyses, Levene's test of homogeneity of variance may be employed to assess whether this assumption has been met sufficiently. Regarding multivariate analyses, Box's M may be used; Tabachnick and Fidell (2007), however, suggest caution in that this test may be too strict when sample sizes are very large, as is often required when dealing with multivariate applications such as these.

For RQ2 ANCOVA and MANCOVA analyses, interface visual aesthetics and verbal information pertaining to the quality of the educational task (the independent variables) were entered as fixed factors, with students' prior knowledge and interest each entered as covariates (preliminary analyses showed no significant differences between groups with respect to either covariate). MANCOVA was employed for the first three analyses (RQ2.1-RQ2.3). For the first analysis, data representing students' initial impressions about the task entered as the dependent variables; for the second analysis, data pertaining to students' expectancies and values were entered as the dependent variables; data representing students' achievement-related choices were entered as the dependent variables for the third analysis; lastly, post-activity knowledge scores

were entered as the dependent variable when conducting the forth analysis (RQ2.4), which utilized the ANCOVA technique.

For a factorial ANCOVA analysis, tests of between-subject effects are examined with respect to interaction effects. If an interaction exists, the cell means should be plotted in an interaction graph. The test is then followed up by conducting a one-way ANOVA across the levels of the other independent variables. If, on the other hand, it is found that no interaction exists, then tests for main effects of each independent variable will be performed separately. Given that one of the factors includes three groups (as opposed to just two), interpretation of significant main effects for this variable will be followed up with contrasts that will break down the main effects in order to determine just where differences between the groups exist. For any significant results from the analysis, effect sizes will also be obtained in order to ascertain the magnitude, or strength, of the effect so that its practical implications may be understood.

As an extension of ANCOVA, MANCOVA analyses exhibit the basic characteristics of the ANCOVA premise and technique. Its multivariate aspect with respect to the handling of multiple dependent variables, however, necessitates certain differences in its consideration and approach. For instance, MANOVA tends to work very well when the dependent variables are highly negatively correlated and acceptably well when correlations are of moderate strength in either direction (Tabachnick & Fidell, 2007). If correlations between dependent variables are high, then one may want to consider (for instances in which it makes sense to do so) dropping those of less empirical value or combining them. Due to the factorial design of this research, where groups may differ along more than one variable, Pillai's trace is recommended as the test statistic that will provide the most power (Field, 2009). Lastly, the main MANCOVA will be followed up with separate ANCOVAs for each of the dependent variables in order to examine

possible effects of the independent variables with respect to each dependent variable.

4.3.1   Research Question 2.1

> RQ2.1 After equating groups with respect to prior knowledge and
> individual interest in genetics, do interface visual aesthetics, verbal
> information pertaining to the quality of the educational task, or
> combinations of different conditions from both factors have an
> effect on: *students' first impressions of the task?*

Due to findings from RQ1, which indicated three underlying dimensions of students'

impressions of the task, the decision was made to apply the MANCOVA technique with the three

dimensions entered as the dependent variables. As mentioned earlier, the MANOVA technique

tends to be less effective when the correlations between DVs highly positively correlated. Thus,

if $r > .60$, the recommendation is to consider dropping or combining variables in a way that is

still theoretically sound (Leech, et al., 2011). Spearman correlation data regarding the nature of

the relationship between these variables showed fairly strong correlations between all three

underlying dimensions of first impressions of the task, in particular with respect to *Social*

Experience (See Table VI). However, because the analysis from RQ1 identified these dimensions

as related—*but uniquely independent*—factors, the 'theoretical' decision was made to enter these

two factors as is, versus combining them and entering them as one variable.

Table VI

Correlation Coefficients for Relations among the Three Underlying Dimensions of First Impressions of the Task

----

Measure	Caliber	Demands on Learner
Social Experience	.658***	.609***
Caliber	--	.473***
Demands on Learner	--	--

Note. 'Demands on Learner' was reverse-coded such that lower values reflect perceptions of a more demanding task.
***$p < .001$

To ascertain whether and in what ways students' impressions of the task (their expectations with respect to the task's quality characteristics) might be influenced by differences pertaining to certain contextual elements of the learning environment, a two-way between-groups multivariate analysis of covariance was conducted. Three dependent variables were examined with respect to students' impressions of the task: *Social Experience, Caliber,* and *Demands on the Learner.* These were assessed with respect to interface visual aesthetics and verbal information provided to students about the task, while accounting for the influence of students' prior knowledge and individual interest in the subject matter.

In addition to other assumption tests, already discussed, Box's Test yielded a significant result, $p < .001$, violating the assumption of equality of variance/covariance. However, Box's Test is also known as a notoriously sensitive test statistic that should be viewed with caution, especially with larger sample sizes. If groups are of nearly equal size, the test can be disregarded (Tabachnick & Fidell, 2007). Additionally, use of Pillai's criterion instead of Wilk's Lambda is recommended to offset potential distortion, which is the case in the analyses for this research (Tabachnick & Fidell, 2007). Results are summarized in Tables VII and VIII.

Table VII

Mean Scores and Standard Deviations for Measures of First Impressions as a function of Interface Aesthetics and Verbal Information

Group	n	First Impression Measures					
		Soc Exp		Caliber		Demands	
		M	SD	M	SD	M	SD
Basic							
Unfavorable	43	8.79	4.95	12.47	3.66	8.09	2.69
Neutral	25	10.56	4.74	13.48	3.37	8.16	3.36
Favorable	35	10.23	4.19	13.06	3.96	8.63	2.51
Embellished							
Unfavorable	30	18.23	4.30	15.50	2.15	10.47	2.33
Neutral	33	17.88	3.58	15.39	1.60	10.42	2.12
Favorable	30	18.77	2.74	16.23	1.74	10.80	2.40

Note. 'Soc Exp' = Social Experience. 'Demands' = Demands on Learner.
'Demands on Learner' was reverse-coded such that lower values reflect perceptions of a more demanding task.

Table VIII

Multivariate and Univariate Analyses of Variance for Students' First Impressions as a Function of Interface Aesthetics and Verbal Information about the Task.

	Multivariate	Univariate		
		Soc Exp	Caliber	Demands
Variable	$F(6, 374)$	$F(2, 188)$	$F(2, 188)$	$F(2, 188)$
Prior Knowledge	3.35*	1.79	4.49*	8.07**
Individual Interest	.93	.27	2.37	.00
Interface Aesthetics (A)	66.50***	191.91***	40.09***	36.33***
Verbal Information (V)	.63	1.16	1.23	.77
A x V	.66	1.19	1.12	.06

Note. Multivariate *F* ratios were generated from Pillai's statistic. 'Soc Exp'=Social Experience. 'Demands'=Demands on Learner.

*p < .05. **p < .01. ***p < .001.

After adjusting for students' prior knowledge and individual interest, results showed no interaction effect between the two independent variables $F_{(6, 374)} = .66$, $p = .686$, Pillai's Trace = .02, partial eta squared = .01. A statistically significant main effect was found, however, on outcome measures between users of the Embellished versus the Basic aesthetic designs, $F_{(3, 186)} = 66.50$, $p < .001$, Pillai's Trace = .52, with a large effect size (partial eta squared = .52). This indicates that the linear composite of dependent variables differs with respect to the aesthetic design of the interface used by students. Results regarding the effect of verbal information provided to students about the task were not significant, $F_{(6, 374)} = .63$, $p = .709$, Pillai's Trace = .02, partial eta squared = .01. Although students' prior knowledge was found to be a significant predictor of students' impressions of the task, $F_{(3, 186)} = .93$, $p < .05$, Pillai's Trace = .05, partial eta squared = .05, their individual interest in the subject matter was not, $F_{(3, 186)} = .93$, $p = .426$,

Pillai's Trace = .02, partial eta squared = .02.

Follow-up ANCOVAs for each of the three dependent variables exhibited a very similar pattern. After adjusting for students' prior knowledge and individual interest, no significant effects were found with respect to an interaction between the independent variables, nor the verbal information provided to students about the task. Once again, results showed a statistically significant main effect of interface visual aesthetics on students' first impressions of the task with respect to each sub dimension for first impressions of the task: *Social Experience* ($F_{(1, 188)}$ = 191.91, $p < .001$, eta squared = .50, indicating a large effect size), *Caliber* ($F_{(1, 188)}$ = 40.09, $p < .001$, eta squared = .17), and *Demands on the Learner* ($F_{(1, 188)}$ = 36.33, $p < .001$, eta squared = .16). It should be noted, however, that Levene's Test of equality of error variances yielded a significant result for the *Caliber*, indicating that this assumption had not been met for this variable and thus should be viewed with caution.

These results show that interface visual aesthetics had a significant effect on all three dimensions of students' impressions of the task, especially with respect to how they perceive the *Social Experience* it will provide. It also appears that the verbal information provided to students about the task did not influence students' initial impressions of the task (as operationalized in this research) in any significant way. Taking things a step further, how might manipulations to contextual components of the task affect students' perceptions of the task in relation to themselves? Might the task seem more or less 'doable'? Might they have influence over the task's perceived importance in relation to students' own goals? These thoughts are addressed in the second part of this research question:

4.3.2   Research Question 2.2

> RQ2.2 After equating groups with respect to prior knowledge and
> individual interest in genetics, do interface visual aesthetics, verbal
> information pertaining to the quality of the educational task, or
> combinations of different conditions from both factors have an
> effect on: *students' expectancies and how they value the task?*

To ascertain whether and in what ways students' expectancies and how they value the task might be influenced by differences pertaining to certain contextual elements of the learning environment, a two-way between-groups multivariate analysis of covariance was conducted. Five dependent variables were examined, representing the star components of Eccles and Wigfield's (2002) expectancy-value theory: students' expectancies for the given task and the four ways of valuing that task (intrinsic value, utility value, attainment value, and cost). These were assessed with respect to interface visual aesthetics and verbal information provided to students about the task, while accounting for the influence of students' prior knowledge and individual interest in the subject matter. In addition to other assumption tests, already discussed, Box's Test yielded a result of $p = .001$, indicating that the assumption of equality of variance/covariance had again been violated. As discussed earlier however, Box's Test should be viewed with caution, and the use of Pillai's criterion (as is the case in these analyses) versus of Wilk's Lambda is recommended to offset potential distortion in multivariate analyses (Tabachnick & Fidell, 2007). Results of the analysis are summarized in Tables VIV, X, and XI.

Table IX

Correlation Coefficients for Relations among Expectancies and Task Values

Measure	Intrinsic V	Utility V	Attain V	Cost
Expectancies	.640***	.370***	.382***	.548***
Intrinsic Value	--	.455***	.501***	.339***
Utility Value	--	--	.558***	.140
Attainment Value	--	--	--	.072
Cost Value	--	--	--	--

Note. 'V' = Value. 'Attain V' = Attainment Value.
***$p < .001$

An examination of Spearman correlation coefficients for the dependent variables yielded relations within the acceptable range, with the exception of that between Expectancies and Intrinsic Value, which showed a strong, positive correlation over .60 (r = .640). The decision was made to enter all five variables as is because, theoretically, each are distinctly defined in the literature, and it is a goal of this research was to examine these constructs with respect to experimental treatments.

After adjusting for students' prior knowledge and individual interest, multivariate results showed a statistically significant main effect on outcome measures between users of the Embellished versus the Basic interface designs, $F_{(5, 184)} = 14.60$, $p < .001$, Pillai's Trace = .28, partial eta squared = .28. Results regarding the effect of verbal information provided to students about the task were not significant, $F_{(10, 370)} = .86$, $p = .575$, Pillai's Trace = .05, partial eta squared = .02, nor was the interaction between the two independent variables $F_{(10, 370)} = .73$, $p =$

.696, Pillai's Trace = .04, partial eta squared = .02. Students' prior knowledge was found to be a significant predictor of students' impressions of the task, $F_{(5, 184)}$ = .3.72, $p < .01$, Pillai's Trace = .09, partial eta squared = .09, as was their individual interest in the subject matter, $F_{(5, 184)}$ = 28.97, $p < .001$, Pillai's Trace = .44, partial eta squared = .44.

These results indicate that the aesthetic design of an educational website's interface is influential over students' expectancies and how they value the task prior to engagement with it. Students using the Embellished version of the website had significantly higher scores in terms of the linear composite representing their expectancies and values with respect to the task. Once again, it appears that the verbal information provided to students had no effect.

To examine results in more detail, follow-up ANCOVA analyses were performed with respect to each of the five dependent variables. After adjusting for students' prior knowledge and individual interest, results showed a statistically significant main effect of interface visual aesthetics on students' *expectancies* ($F_{(1, 188)}$ = 29.15, $p < .001$, eta squared = .11) and how they valued the task in terms of *intrinsic value* ($F_{(1, 188)}$ = 55.16, $p < .001$, eta squared = .20) and *cost* ($F_{(1, 188)}$ = 18.37, $p < .001$, eta squared = .08). No significant effects were found with respect to an interaction between the independent variables, nor the verbal information provided to students about the task. Interestingly, prior knowledge was found to be a significant predictor with respect to *expectancies* and *cost* only, while individual interest in the subject matter was a significant predictor for all five dependent variables.

Table X

Mean Scores and Standard Deviations for Measures of Expectancies and Values as a function of Interface Aesthetics and Verbal Information

	Measures of Expectancies and Task Values									
	Expectancies		Intrinsic V		Utility V		Attainment V		Cost	
Group	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Basic										
Unfavorable	9.42	3.02	6.05	4.69	8.51	4.35	8.28	4.65	8.65	4.12
Neutral	8.52	4.25	6.24	4.35	7.88	3.98	8.08	4.35	7.60	6.61
Favorable	9.20	2.73	7.17	3.79	8.06	3.45	7.69	3.89	8.37	3.80
Embellished										
Unfavorable	10.57	3.68	10.07	4.27	8.30	3.58	7.77	4.46	10.50	3.64
Neutral	12.24	3.03	10.85	4.09	8.33	3.46	9.15	4.32	11.36	4.71
Favorable	11.27	2.60	10.93	3.36	8.43	3.46	7.60	4.79	10.20	4.05

Note. 'V' = Value. Additionally, 'Cost' was reverse-coded so that higher numeric values reflect perceptions of lower cost.

Table XI

Multivariate and Univariate Analyses of Variance for Students' Expectancies and Task Values as a Function of Interface Aesthetics and Verbal Information about the Task.

Variable	Multivariate	Univariate				
		Expectancies	Intrinsic V	Utility V	Attain V	Cost
	$F(10, 370)$	$F(2, 188)$	$F(2, 188)$	$F(2, 188)$	$F(2, 188)$	$F(2, 188)$
Prior Knowledge	3.72**	17.92***	2.51	.09	1.35	4.77*
Individual Interest	28.97***	15.98***	22.75***	111.29***	82.84***	4.32*
Interface Aesthetics (A)	14.6***	29.14***	55.16***	.48	.19	18.37***
Verbal Information (V)	.86	.61	1.90	.68	.38	.01
A x V	.73	2.26	.19	.14	.74	.90

Note. Multivariate *F* ratios were generated from Pillai's statistic. 'V'=Value. 'Attain V'=Attainment Value.

*$p < .05$. **$p < .01$. ***$p < .001$.

Taking things further still regarding the learning process, how might manipulations to contextual components of the task affect student behavior in terms of engagement with the learning activity? Is it possible that these manipulations are influential over actions that speak to educational achievement?

4.3.3   Research Question 2.3

RQ2.3 After equating groups with respect to prior knowledge and individual interest in genetics, do interface visual aesthetics, verbal information pertaining to the quality of the educational task, or combinations of different conditions from both factors have an effect on: *students' achievement-related choices?*

To answer this question, a two-way between-groups multivariate analysis of covariance was conducted. Three dependent variables were examined, representing the total number of web page visits that were made during the task, the total amount of time spent doing the task, and the proportion of visits to pages within the site that were relevant to the goals of the learning activity (relevant content material). These were assessed with respect to interface visual aesthetics and verbal information provided to students about the task, while accounting for the influence of students' prior knowledge and individual interest in the subject matter. In this analysis, Box's Test yielded a significant result, $p < .05$, indicating that the assumption of equality of variance/covariance had not been met. As previously discussed, the sensitivity of this test should be viewed with caution with larger sample sizes. The decision was also made to employ use of Pillai's Trace for multivariate analyses to offset the distortion of alpha levels. Results are

summarized in Tables XII, XIII, and XIV.

Table XII

Correlation Coefficients for Relations among Measures of Achievement-related Choices

----

Measure	Tot Time	PVRC
Tot Visits	.486***	-.252***
Tot Time	--	.001
PVRC	--	--

Note. 'Tot Visits' = Total number of website page visits. 'Tot Time' = Total time on task. 'PVRC' = Proportion of Visits to Relevant Content pages.
***$p < .001$

An examination of Pearson Product Moment correlation coefficients for the dependent variables showed that, although time on task and the proportion of students' visits to relevant content info did not appear to be related, the three were still inter-related at a moderate level and thus within the acceptable range (r < .60).

After adjusting for students' prior knowledge and individual interest, multivariate results showed a statistically significant main effect on outcome measures between users of the Embellished versus the Basic interface designs, $F_{(3, 179)} = 5.38$, $p = .001$, Pillai's Trace = .08, partial eta squared = .08. Results regarding the effect of verbal information provided to students about the task were not significant, $F_{(6, 360)} = 1.22$, $p = .298$, Pillai's Trace = .04, partial eta squared = .02, nor was the interaction between the two independent variables $F_{(6, 360)} = .23$, $p =$

.967, Pillai's Trace = .008, partial eta squared = .004. Interestingly, neither students' prior knowledge, $F_{(3, 179)}$ = .97, p = .409, Pillai's Trace = .02, partial eta squared = .02, nor their individual interest in the subject matter, $F_{(3, 179)}$ = .99, p = .401, Pillai's Trace = .02, partial eta squared = .02, were significant predictors of scores on representing students' achievement-related choices on this task. These results indicate that the aesthetic design of an educational website's interface is influential over how students' engage with the educational task in terms of the linear combination of achievement-related choices measured in this analysis.

To examine results in more detail, follow-up ANCOVA analyses were performed with respect to each of the three dependent variables. Levene's Test of equality of error variances yielded insignificant results for all three, indicating that this assumption had been met. After adjusting for students' prior knowledge and individual interest, results showed a statistically significant main effect of interface visual aesthetics on the proportion of students' visits to relevant content information regarding the task goals ($F_{(1, 181)}$ = 7.32, p < .01, eta squared = .04), where students using the Basic version of the interface visited a significantly higher proportion of relevant pages (M = .92, SD = .13) versus those using the Embellished design (M = .86, SD = .17). No significant effects were found with respect to the total number of visits made throughout the site, nor the amount of time students spent using the site in order to learn about the targeted content areas.

Table XIII
Mean Scores and Standard Deviations for Measures of Achievement-related Choices as a function of Interface Aesthetics and Verbal Information

	Measures of Achievement-related Choices					
	Tot Visits		Tot Time		PVRC	
Group	*M*	*SD*	*M*	*SD*	*M*	*SD*
Basic						
Unfavorable	13.5	6.6	609.0	417.3	.904	.136
Neutral	14.2	7.4	587.4	472.6	.901	.128
Favorable	12.1	6.5	554.4	445.8	.943	.115
Embellished						
Unfavorable	14.3	6.4	453.7	398.6	.840	.194
Neutral	16.7	4.9	483.9	277.8	.853	.180
Favorable	14.1	6.0	536.1	402.1	.878	.139

Note. 'Tot Visits' = Total number of website page visits. 'Tot Time' = Total time on task. 'PVRC' = Proportion of Visits to Relevant Content pages.

Table XIV
Multivariate and Univariate Analyses of Variance for Students' Achievement-related Choices as a Function of Interface Aesthetics and Verbal Information about the Task.

		Univariate		
	Multivariate	Tot Visits	Tot Time	PVRC
Variable	$F(6, 360)$	$F(2, 181)$	$F(2, 181)$	$F(2, 181)$
Prior Knowledge	.97	2.57	.15	.003
Individual Interest	.99	.26	.75	2.24
Interface Aesthetics (A)	5.38**	3.37	2.29	7.32**
Verbal Information (V)	1.00	2.00	.05	.92
A x V	.49	.21	.40	.07

Note. Multivariate *F* ratios were generated from Pillai's statistic. 'Tot Visits'=Total number of visits to website pages. 'Tot Time'=Total time on task. 'PVRC'=Proportion of Visits to Relevant Content pages.
**$p < .01$.

The ultimate goal of engagement with an educational task, of course, is for the individual to have learned something, to have acquired some kind of new knowledge. Might the manipulation of certain contextual elements of the learning environment as part of the presentation of the task be influential enough to affect how well students actually learned with it?

4.3.4   Research Question 2.4

RQ2.4 After equating groups with respect to prior knowledge and individual interest in genetics, do interface visual aesthetics, verbal information pertaining to the quality of the educational task, or combinations of different conditions from both factors have an effect on: *how well students learned with the task?*

To determine whether and in what ways students' learning outcomes might be influenced by differences pertaining to interface visual aesthetics and/or verbal information provided about the task, a two-way between-groups analysis of covariance was conducted. Students' scores from a post-task assessment of topic knowledge were examined. These scores were assessed with respect to interface visual aesthetics and verbal information provided to students about the task, while accounting for the influence of students' prior knowledge and individual interest in the subject matter. Levene's Test of equality of error variances yielded a non-significant result, $p > .05$, indicating that this assumption had been met. Results are summarized in Tables XV and XVI.

Table XV
Mean Scores and Standard Deviations for Post-activity
Topic Knowledge as a function of Interface Aesthetics and
Verbal Information

| | | Post-Knowledge | |
Group	n	M	SD
Basic			
Unfavorable	43	7.51	2.46
Neutral	25	6.68	2.38
Favorable	35	7.00	2.31
Embellished			
Unfavorable	30	6.30	2.55
Neutral	33	7.21	2.42
Favorable	30	7.60	2.86

Table XVI
Analysis of Covariance of Post-activity Topic Knowledge Scores as a Function of Interface Aesthetics and Verbal Information

Source	df	SS	MS	F	η^2
Prior Knowledge	1	182.15	182.15	36.65***	.16
Individual Interest	1	12.90	12.90	2.60	.01
Interface Aesthetics (A)	1	.77	.769	.155	.001
Verbal Information (V)	2	11.84	5.92	1.19	.01
A x V	2	31.94	15.97	3.21*	.03
Error	188	934.39	4.97		
Total	196	1173.99			

*p < .05. ***p < .001.

Results showed a statistically significant interaction effect of the independent variables on learning outcomes, $F_{(2, 188)} = 3.21$, $p < .05$, partial eta squared = .03. Additionally, this time no significant main effects were found with respect to interface visual aesthetics, $F_{(1, 188)} = .16$, $p = .695$, partial eta squared = .001, nor the verbal information provided to students about the task, $F_{(2, 188)} = 1.19$, $p = .306$, partial eta squared = .01. Although students' prior knowledge was found to be a significant predictor of students' learning outcomes, $F_{(1, 188)} = 36.65$, $p < .001$, partial eta squared = .16, their individual interest in the subject matter was not, $F_{(1, 188)} = 2.60$, $p = .109$, partial eta squared = .01. Surprisingly, these results suggest that verbal information provided to students about the task *does* carry over, and in both expected and unexpected ways, depending on the kind of aesthetic design students used (See Figure 6). Simple effects were examined using post-hoc pairwise comparisons, which revealed more detail about significant differences between the groups in this study:

1) Students in the 'Embellished aesthetic + Unfavorable verbal info' condition and those in the 'Embellished aesthetic + Favorable verbal info' condition had Post-Knowledge scores that differed significantly: Students who received Favorable information about the quality of the educational website scored significantly higher on the assessment ($M = 7.60$, $SD = 2.86$) than those students who received Unfavorable information about it ($M = 6.30$, $SD = 2.55$). Worth noting is that scores from students in the 'Embellished aesthetic + Neutral verbal info' condition fell in between the Favorable and Unfavorable groups using the Embellished design. Thus scores increased/decreased in logical progression by group. This pattern was *not* found among students who used the Basic design.

2) Students who were told Unfavorable info differed significantly with respect to the
   aesthetic design they used: Basic versus Embellished. Students using the Basic design
   scored significantly higher on the knowledge assessment ($M = 7.51$, $SD = 2.46$) in
   comparison with students using the Embellished design ($M = 6.30$, $SD = 2.55$), an
   unexpected finding. In fact, students who used the Basic design and received
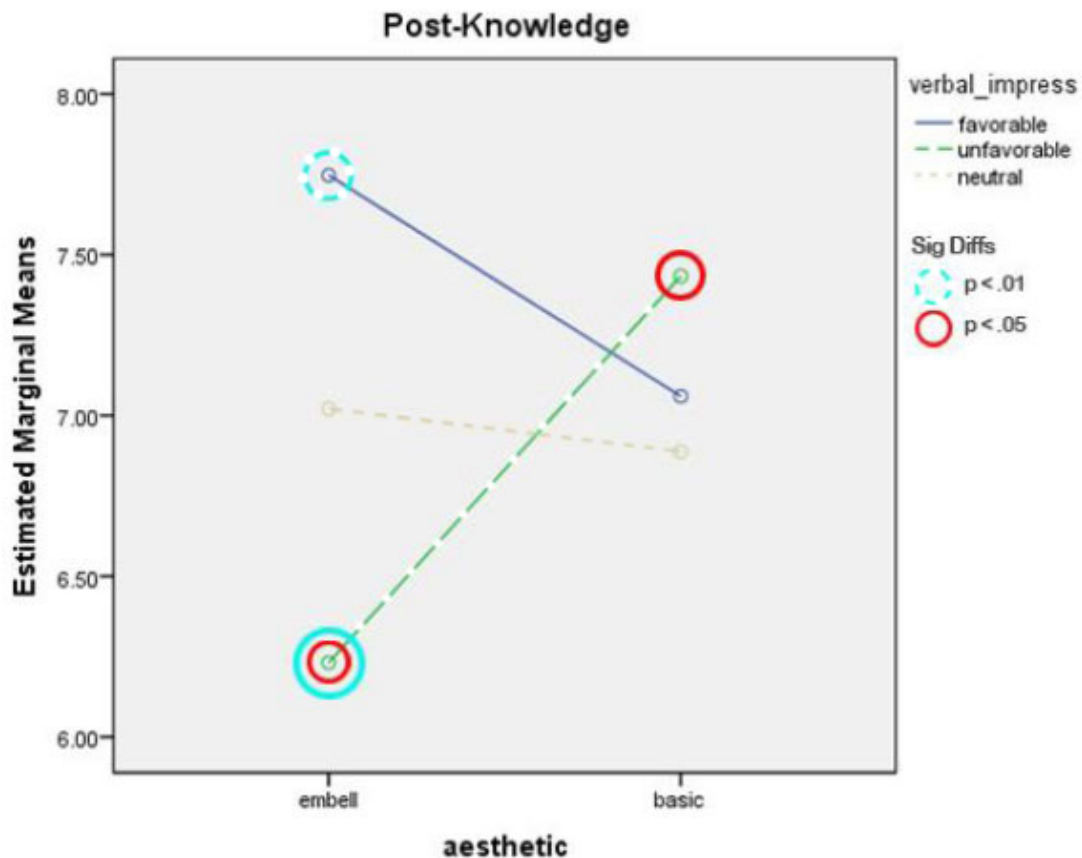   Unfavorable info received higher mean scores than the other 'Basic aesthetic' groups.

Figure 6

These results suggest that manipulations to the presentation of information can interact in complex ways, yielding results that may not necessarily be intuitive. To ascertain a better understanding of the situation, post-activity topic knowledge was examined once again, but this time with respect the kind of knowledge required of students to answer the assessment questions: *Surface-level* and *Deep-level* knowledge, as called for by the different items (See Appendix E).

A multivariate two-way analysis of covariance was conducted, with scores for Surface-level and Deep-level knowledge entered as the dependent variables ($r = .417$, $p < .001$). Box's Test of equality of covariance matrices yielded an insignificant result, indicating that this assumption had been met. Results are summarized in Tables XVII and XVIII.

Table XVII
Mean Scores and Standard Deviations for Measures of Surface and Deep Level Topic Knowledge as a function of Interface Aesthetics and Verbal Information

| | Knowledge Measures | | | |
| | Surface-Level | | Deep-Level | |
Group	*M*	*SD*	*M*	*SD*
Basic				
Unfavorable	4.37	1.23	3.14	1.68
Neutral	3.72	1.46	2.96	1.46
Favorable	3.80	1.35	3.20	1.41
Embellished				
Unfavorable	3.73	1.46	2.57	1.57
Neutral	4.18	1.26	3.03	1.65
Favorable	4.20	1.27	3.40	1.96

Table XVIII
Multivariate and Univariate Analyses of Variance for Measures of Surface and Deep Level TopicKnowledge as a Function of Interface Aesthetics and Verbal Information about the Task.

		Univariate	
	Multivariate	Surface	Deep
Variable	*F* (4, 376)	*F* (2, 188)	*F* (2, 188)
Prior Knowledge	18.24***	22.23***	26.05**
Individual Interest	3.75*	7.11**	.06
Interface Aesthetics (A)	.38	.04	.55
Verbal Information (V)	1.11	.14	2.04
A x V	2.05	3.73*	1.30

Note. Multivariate *F* ratios were generated from Pillai's statistic. 'Surface'=Surface-level knowledge. 'Deep'=Deep-level knowledge.
*p < .05. **p < .01. ***p < .001.

After accounting for out the possible effects of prior knowledge and individual interest in the subject matter, the analysis yielded no significant effects at the multivariate level regarding the independent variables. Thus follow-up ANCOVAs were examined. Levene's test for equality of error variances was satisfied. At the univariate level, results showed a significant interaction between interface aesthetics and verbal information—*with respect to the Surface-level knowledge items only*, $F_{(2, 188)} = 3.73$, *p* < .05, eta squared = .03. Similar to the initial post-knowledge score analysis (which included *Surface-level* and *Deep-level* items), no significant main effects were found.
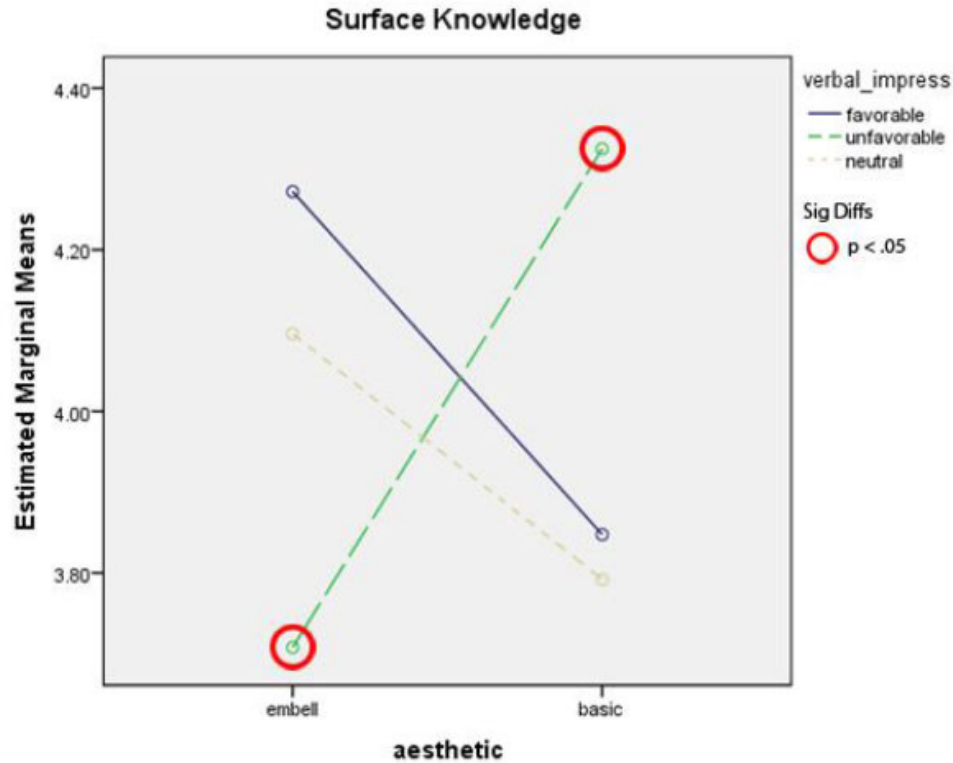
Figure 7

To delve deeper into the details of the interaction with respect to the respective groups, simple effects were examined with post-hoc pairwise comparisons. One significant difference was found: Once again, scores for students who received Unfavorable verbal information differed significantly with respect the aesthetic design they used for the task (See Figure 7, above). Similar to the initial post-knowledge analysis, these scores suggest differences in the patterns we can expect to see, based on certain combinations regarding manipulations to the presentation of the task.

4.4   Point of Comparison Check

Finally, it should be known that 'Point of Comparison' scores were also analyzed. These measures were developed as an assurance of internal validity to the study with respect to perceptions of the Basic versus Embellished interface designs. Before concluding the research activity (and after students had already interacted with the educational website and completed the post-knowledge assessment), students were shown both versions of the interface and asked to rate each with respect to attractiveness and professional appearance. A paired t-test was conducted to confirm that the two interface designs were 'aesthetically engineered' in such a way that perceptions of how attractive and professional they appeared to viewers would be markedly different. Results (summarized in Table XIX) show a significance difference between the two aesthetic designs with respect to both dependent measures, where the Embellished design was seen as being both significantly more attractive and significantly more professional than its Basic design counterpart. These results support the internal validity of the study regarding the educational website's ability to elicit differing impressions from viewers by way of the interface's aesthetic design.

Table XIX

Differences in Students' Post-Activity Perceptions of the Basic versus the Embellished Website Interface Designs with Respect to 'Attractiveness' and 'Professionalism' after Viewing Both

	Basic Design		Embellished Design			
Group and Measure	*M*	*SD*	*M*	*SD*	*df*	*t*
Used Basic						
Attractive	2.04	1.06	4.95	.97	100	-18.42***
Professional	2.78	1.39	5.17	.81	100	-14.54***
Used Embellished						
Attractive	1.51	.10	5.04	1.03	91	-21.27***
Professional	2.26	1.41	5.17	1.11	91	-14.56***

***$p < .001$.

CHAPTER 5

DISCUSSION

This research sought to gain a better understanding of the notion of the 'all important first impression' as it relates to online learning by (1) investigating in more detail just what constitutes students' impressions of an impending educational task via the measurement of this construct and (2) examining how manipulations designed to elicit differing initial perceptions about what is essentially the same task might affect elements of the learning process with respect to that task: first impressions, the formation of expectancies and task values, achievement-related choices, and finally the quality of learning that results.

Research Question 1 consisted of two parts, each of which is discussed below.

5.1   Research Question 1.1

RQ1.1. Can students' 'impressions of an educational task' be measured in such a way that this construct is successfully operationalized with respect to the characteristics of the task that speak to its quality?

A major goal of this research investigation is to understand the nature of students' impressions of an educational task as a function of the way the task is presented to them. As discussed in Chapter 2, the existing literature base regarding people's impressions of a task/activity remains at a general level representative of 'overall goodness' when measuring impression formation (Cheon & Grant, 2009; Lindgaard, et al, 2006; Norman, 2004; Schenkman

& Jonssons, 2000; Skadberg & Kimmel, 2004; Um, 2009). From a design perspective, it would be helpful to have a more substantive understanding of what a first impression of a task actually entails. What is in a first impression? What kinds of perceptions contribute to the impressions students form about an impending task? To this end, an 11-item *Impression of the Task* scale was developed by the researcher and administered as part of the protocol for this research investigation. This scale contains items representing various likely contributors to an overall first impression (i.e., perceived: enjoyableness, effectiveness, understandability, trustworthiness, amount of effort required, level of interactivity, ease of use, quality of content, current-vs.-outdated status, attractiveness).

A Cronbach's Alpha of .91 revealed a high level of reliability for students' *Impressions of the Task* and confirmed the contribution of various perceptions captured as part of the scale. Additionally, results from tests of predictive validity supported the scale's ability to measure this particular construct. While it is good to know, on one level, that numerous different ways of perceiving a task play a role in the formation of students' initial impressions of it, on another level it would also be useful to know whether the many can be pared down to perhaps a few 'categories' of impression formation (sub-constructs) that educators/designers can focus on in the presentation of tasks to students for more optimal effect.

5.2   Research Question 1.2

RQ1.2. What underlying dimensions might exist with respect to

students' impressions of a computer-based educational task?

An exploratory factor analysis of the items in this scale cleanly revealed three distinct,

underlying dimensions for students' *Impressions of the Task*: perceived *Social Experience*, *Caliber*, and *Demands on the Learner*. The third construct, *Demands of the Learner*, appears to align with what Eccles and Wigfield (2002) have described as task demands. Together, they explain a hefty 75.8% of the variance in students' scores. Individually, perceptions with respect to *Social Experience* account for the overwhelming majority of the variance (55.4%), with *Caliber* and *Demands on the Learner* explaining 11.0% and 9.3%, respectively. Regarding the creation of educational tasks, educators/designers ought to keep these three sub-constructs in mind when considering how students may come to perceive—and thus receive—the tasks assigned to them, especially with respect to the kind of social experience that awaits them.

This leads one to wonder: How does the 'receiving' of the task manifest in students with respect to the learning process (ranging from their first impressions of it to how well they actually learn with it)? Research Question 2 answers this question in four parts, each corresponding to different points in a learner's progression through the task.

5.3   Research Question 2.1

RQ2.1 After equating groups with respect to prior knowledge and individual interest in genetics, do interface visual aesthetics, verbal information pertaining to the quality of the educational task, or combinations of different conditions from both factors have an effect on: *students' first impressions of the task?*

For this question, students' first impressions of the task were operationalized based on findings from RQ1.2 and examined with respect to perceptions about the impending *Social*

Experience, *Caliber* of the task, and the task's *Demands on the Learner*. A MANCOVA found no interaction effect between the two factors, nor any significant effect with respect to differences in the kind of verbal information provided to students that pertained to the task's quality. In this analysis, it was the website's interface aesthetics alone—basic versus embellished—that elicited a significant difference in students' first impression scores, and this effect spanned across all three dimensions of the first impression construct. In line with results from RQ1.2, the effect size was large with respect to perceived *Social Experience* but more moderate with respect to the other two sub-dimensions of the first impression construct. These results indicate that in the creation of online educational tasks, the aesthetic design implementation can significantly influence impression formation in learners with respect to the social experience they expect to have, perceptions about the task's caliber, and how demanding they perceive the task will be on them. In this case, those using the Embellished aesthetic design formed impressions about the task that were significantly more favorable than those using the Basic design.

Because past research by Fries, Hors, and Haimerl (2006) showed that the type of verbal information given to students about the quality of the task made a significant difference in students' learning outcomes, one would think that results in the present study would yield some kind of difference between groups regarding their impressions of the task—especially given that the experimental conditions of *this* research (with respect to the verbal information variable) were modeled off the former. Yet that was not the case. Based on the findings in this analysis, it is possible that the visual aspect of impression formation may have somehow trumped or mitigated the influence that verbal information about task quality may have had on students. This could be due to the fact that the visual cues about the task's quality were presented *after* the

verbal, invoking some kind of recency effect. It could also be a function of the medium itself: people tend to rely heavily on visual cues when interpreting and interacting with the world around them. Perhaps the visual cues provided by the aesthetic design of the interface simply outweighed that of the verbal information given to students. Knowing for certain what is behind these results (the 'timing of the priming,' the power of the visual medium, or something else entirely) would require additional investigation.

These results also lead one to wonder whether the answers to the remaining research questions (RQ2.2-RQ2.4) would yield a similar pattern in terms of the lack of an interaction effect and a significant main effect for interface visual aesthetics only. Additionally, how far-reaching are the effects of aesthetic design in terms of the learning process?

5.4   Research Question 2.2

RQ2.2 After equating groups with respect to prior knowledge and individual interest in genetics, do interface visual aesthetics, verbal information pertaining to the quality of the educational task, or combinations of different conditions from both factors have an effect on: *students' expectancies and how they value the task?*

When appraising an impending educational task, students not only perceive information pertaining to the task's quality characteristics, but they must also relate what 'they see the task to be' with *themselves* as individuals in order to assess what kind of success they expect to achieve, and whether and in what ways doing the task may hold value for them. These are the constructs central to Eccles and Wigfield's (2002) modern expectancy-value theory of achievement

motivation.

The MANCOVA for RQ2.2 showed a similar result at the multivariate level to that of RQ2.1: no interaction effect or main effect for verbal information was found. Also similar to the previous analysis, it was the aesthetic design of the website's interface (basic versus embellished) alone that yielded a significant main effect when examining students' linear composite scores for the following dependent variables: how confident they were in their ability to complete the task successfully (expectancies); how 'interesting' they thought the task would be to them (intrinsic value); how 'useful' they thought doing the task would be per their own life goals; how 'personally important' it was for them to do well on the task, given how it relates their self-conceptions (attainment value); and what doing the task would 'cost' them in terms of lost time, too much effort, and stress (cost). Again, students using the Embellished interface design displayed significantly more favorable attitudes toward the educational website than students using the Basic interface design.

Looking at the dependent variables separately, results indicated a significant influence of the site's interface aesthetics on scores for students' expectancies, intrinsic value, and cost—but *not* for utility value or attainment value. These results make sense in that expectancies, interest in the given task, and perceptions of 'cost' are all situational and very much tied to the observable specifics of the task. Utility value and attainment value, in contrast, are more strongly tied to a students' own goals and sense of self and are thus less likely to vary in the way that the attitudes represented through the other variables would tend to vary as the details of different learning situations change.

These results are noteworthy for those involved in the design of computer-based educational tasks because they indicate that the visual aesthetics of the interface can significantly

influence students' expectancy levels, how interested they are in doing the task, and the perceived cost of doing it, which all speak to the how individual students may then approach and execute that task. This begs the question: Might the aesthetic design of the interface also carry over into action—how students choose to engage with the given task?

5.5   Research Question 2.3

> RQ2.3 After equating groups with respect to prior knowledge and individual interest in genetics, do interface visual aesthetics, verbal information pertaining to the quality of the educational task, or combinations of different conditions from both factors have an effect on: *students' achievement-related choices?*

Results from this analysis showed, yet again, a multivariate main effect for the interface's aesthetic design, but no interaction effect or main effect with respect to the verbal information provided about the task. An examination of each of the dependent variables—total number of website page visits, total time on task, and proportion of visits to relevant content pages—showed that the two aesthetic design groups differed significantly on just one variable: proportion of visits to relevant content pages. Furthermore, the nature of the difference was unexpected, especially given the findings of this research up until this point: Students using the Basic aesthetic design visited a significantly higher proportion of relevant pages than students using the Embellished design.

Based on these findings, it appears that students using the Basic version of the interface did a better job at staying on task. Perhaps the plainness of the Basic design fostered in students a

more focused state of mind… Would this also translate into better learning outcomes? In contrast, it seems that the aesthetic embellishments to the interface design encouraged students in the Embellished group to navigate to more parts of the website than students in the Basic group—in other words, they made more visits to task-irrelevant pages. On one hand, this could certainly be seen as being less focused on the task at hand; on the other hand, having the curiosity/desire to explore one's learning environment to a greater extent is not necessarily a bad thing. This behavior may be a reflection of these students' significantly more favorable attitudes toward the website as well as their significantly higher scores with respect to expectancies and task values. Students in the Embellished group were more confident in their ability to do the task successfully, they were more interested in doing the task, and they felt that doing it would be less costly than students using the Basic design. Thus the question is whether these 'off-course' visits translate into poorer learning outcomes or not.

5.6   Research Question 2.4

RQ2.4 After equating groups with respect to prior knowledge and individual interest in genetics, do interface visual aesthetics, verbal information pertaining to the quality of the educational task, or combinations of different conditions from both factors have an effect on: *how well students learned with the task*?

Given the findings for RQ2.1-RQ2.3, one would expect to find a main effect for the website interface's aesthetic design, but that was not the case in this analysis. Using students' scores from a post-activity knowledge assessment as the dependent variable, an ANCOVA

yielded a significant interaction effect between interface visual aesthetics and verbal information provided to students about the task. No significant main effects were found. These results suggest that, although not evident in the previous analyses for this research, the verbal information provided to students about the quality of the task *does* ultimately play a role in how well students learn with that task (in conjunction with the aesthetic design of the interface).

Further examination showed in what ways the groups in the study significantly differed with respect to their knowledge scores. As discussed in Chapter 4, the Embellished groups' scores followed a logical pattern where students who received Favorable verbal information pertaining to the website's quality scored the highest—significantly higher than students who received Unfavorable verbal information. Scores from students in the neutral verbal condition fell in between the other two. This pattern reflects what was hypothesized regarding results of the study and closely mimics results from research by Fries, Hors and Haimerl (2006) in terms of the verbal information provided to students about a given task. In contrast, score patterns for students who used the Basic version of the interface were not intuitive, such that those who received *Unfavorable* verbal information about the website actually scored the highest out of the three groups (and significantly higher than students in the 'Unfavorable info + Embellished' condition). These were curious results in need of a plausible explanation.

To gain a more thorough understanding of the results, a second analysis was performed with respect to students' post knowledge scores. This time, the distinction was made between items requiring surface-level knowledge (rote learning and reproduction) and items requiring deep-level knowledge (critical thinking, application, and performance). These were entered as two dependent variables in a MANCOVA. Results indicate that the counter-intuitive phenomenon observed with the 'Unfavorable info + Basic' group was limited to performance on

just the surface-level knowledge items. This presents an interesting contrast with results from the pilot study for this research (Manning, Lawless, & Mayall, 2011), in which students using the professional-looking version of the website scored significantly higher than students using the amateur-looking version on the *deep-level* knowledge items. It should be noted, however, that the designation used in the 2011 study compared 'Amateur versus Professional' site designs, which is a different comparison of constructs than 'Basic versus Embellished' designs used in the current investigation.

Together, the findings from these two RQ2.4 analyses demonstrate the kind of complexities that can arise as different ways of influencing students' perceptions about a task's quality characteristics play out, in both expected and unexpected ways. In this case, the verbal information provided to students about the task yielded differing results, depending on the kind of aesthetic design students used. Additionally, it was uncovered that the *kind of knowledge* being assessed is important to consider in order to have a clear understanding of the story that unfolds.

Of course, questions still remain about the phenomena observed that do not appear in line with what one would expect. At first blush, it would seem that the 'take-away' in this case would be: "If you are going to use a basic/plain/bland-looking educational website, tell your students it is of poor quality so that they may learn and perform at a higher level." This simply does not jibe with years of educational research that tell us this cannot be right. Thus the results from these analyses must be explained in a way that makes better sense.

Past research exists where participants in the 'disadvantaged' group outperformed those in more beneficial treatment conditions (Saretsky, 1972). The situation was one in which the disadvantaged group became aware of their status in comparison with other participants. To

combat the situation, they actually worked *harder* on the given task in order to compensate for the disadvantage. This phenomenon is now known as the 'John Henry effect,' in reference to the legendary folk hero John Henry, a steel driver whose work was compared against a steam drill machine. After becoming aware of his situation, he worked so hard and tirelessly to outperform the steam machine that he actually died from the effort. As it applies to research, the effect indicates a performance bias and is indicative of a breach of experimental protocol, resulting in a violation of internal validity. Such a situation was not the case in the present research; students remained unaware of the other conditions throughout the educational task.

A reexamination of research protocol materials from the current study provided information in support of another explanation. It is possible that the wording used in the instructions to create the 'Unfavorable info' condition may have inadvertently had additional implications other than eliciting perceptions of low quality with respect to the website provided for the task:

> UNFAVORABLE CONDITION: This educational website was developed as a course project by two undergraduate students at UIC: a web design major and a biology major. Because it is currently still under development, it is possible you may come across some minor technical glitches and content-related errors. Information gathered about this site will be used to improve upon its design.

Perhaps by telling students that the site was designed by other students—*students like themselves*, a 'sympathy effect' was produced where students who received the 'Unfavorable info' could relate to the plight of the 'student designers' and thus wanted for those fellow students to succeed at creating a medium through which others can learn. The difference in learning outcomes between the Basic and Embellished conditions for those given 'Unfavorable

info' can be explained by the notion that people are more likely to provide help to those who appear in need of assistance versus those who do not. Upon seeing the Embellished design, students may have been less inclined to personally assist with a successful learning session because the website appeared as attractive and professional looking (empirically more so than its counterpart), eliciting more favorable impressions in terms of social experience, caliber, and demands on the learner (as discussed earlier). The Basic design, on the other hand, was—as its name suggests—very basic in appearance and less likely to impress. Its appearance may have confirmed or supported the initial 'impression' elicited by the 'Unfavorable info' condition, and students remained sympathetic, putting in extra effort to support their comrades.

Taking this explanation a step further, consider that the sample of participants for this research were all pre-service teachers. Perhaps in addition to the 'sympathy effect,' the wording of the 'Unfavorable info' condition induced 'teacher mode' such that these soon-to-be educators aimed to help out by finding items within the website in need of fixing by combing through the web pages for existing "technical glitches and content-related errors," as mentioned in the instructions they received. This would also help to explain the significantly better performance by these students on the surface-level knowledge items in the post-activity assessment versus items targeting deep-level knowledge. While in 'teacher mode,' these students examined the site's content for anything incorrect, keeping them focused on the content at a surface level throughout the task.

Of course, more research is needed to determine whether these explanations truly have merit. For example, would the results be different if the sample had been taken from a different population of students? In addition to keeping in mind that this sample consisted of pre-service teachers, one may also consider the fact that 69% of the participants were female. Also of

interest is how different wording of the 'Unfavorable info' instructions (to avoid triggering a 'sympathy effect' and/or 'teacher mode') might affect learning outcomes. Furthermore, what impact might the addition of extra topic knowledge questions on the post-activity assessment have on students' scores (including surface-level/deep-level scoring) versus the 13 items it contained in the present study?

5.7   Future Directions

At a more general level, there are several questions that speak to the future of this research. First, in addition to examining the effects of manipulations to the presentation of the task (visual and verbal), in what ways would adjustments made to the task itself moderate students' first impressions, their expectancies, how they value the task, their achievement-related choices, and how well they actually learn? In the present study, students finished the entire research protocol in roughly an hour's time. Would extending the duration of the task via additional time or inclusion of more content information have an effect on any of the outcome variables listed? In a similar vein, would modifying the format of the task to accommodate increased interactivity (e.g., videos, 'hands-on' exercises/drills) be influential over collected dependent measures? It is important to be able pinpoint the 'sweet spots' where the quality of one's learning experience is at optimal levels—this necessitates knowing just where/how optimal (and sub-optimal) learning may ebb and flow based on given characteristics of the task: its format, its contents, and how it is presented to learners.

Likewise, it is important to understand more about how samples from different populations may behave differently from each other with respect to the task and how it is presented (aesthetic design; verbal information). For example, what difference might there be

between students with high prior knowledge and students with little to no knowledge when examining the effects of aesthetic design and favorable-versus-unfavorable information provided to students about the educational website? The particular domain of study can also influence the nature of learning (Bransford, Brown, & Cocking, 2000); therefore different areas of knowledge should be explored as well with respect to the present research. In fact, the combination of 'sample population' x 'domain of study' would make for very interesting research in this area. Instead of one genetics website presented in six different ways (as in the present study), imagine one 'genetics' website and one 'color theory' website that are each used by three major groups of students: design majors, biology majors, and one group representing the general university population. How might manipulations to the presentation of the educational website via visual aesthetics and verbal information about the site's quality play out in all of these circumstances?

Further down the line, after more research has served to fine tune what is known and recommended regarding manipulations to the presentation of the task under different circumstances (e.g., sample, domain of study, level of prior knowledge/interest), structural equation modeling (SEM) may be in order. One of the major goals of this research is to expand on what is known with respect to Eccles and Wigfield's (2002) expectancy-value theory of achievement motivation. In their work, they call for a better understanding of the role that contextual elements of learning situations may play in students' levels of motivation and academic achievement. Eventually, findings from the present line of research may help to fill in that gap of knowledge while testing/confirming Eccles and Wigfield's conceptual model in conjunction with manipulations to the presentation of the task. As discussed in Chapter 2, thus far work on the development of this model has been through non-experimental methods; the present research seeks to contribute to existing literature by changing that fact and by examining

learning situations at the 'task-specific' level (micro) versus the much more general 'domain'

level (macro) as has been the case up until this point.

5.8   Limitations

This research, like most any study, is not without certain given limitations. The

participants were pre-service teachers who engaged with a computer-based biology lesson. One

must exercise caution when considering how results and conclusions may be applied to more

general populations. Additionally, one might consider some activities pertaining to this research

as inauthentic in that students generally do not stop (as was asked of participants in this study)

and consciously consider how they feel about the impending task or make explicit interpretations

and judgments about the task at hand. Having participants engage in the research in such a

manner may threaten the researcher's ability to draw completely accurate inferences from the

data, which aspire to reflect real-world thoughts and behaviors. Issues such as this, however, are

not uncommon in lab settings. At a later point in time, it would be possible to resolve the issue

by running the study once more with a modified procedure that excludes the somewhat intrusive

process of obtaining students' task perception data. Results could then be compared to results

from the currently proposed study to validate findings of any first impression effects.

With respect to interface visual aesthetics, it is possible that other aspects of website

design such as the layout of site elements, content information, and functionality can also

influence how students perceive and the impressions they form. Various design controls were

implemented as part of this research to combat this. As discussed earlier, the content

information, layout, and functionality of both versions of the web-based lesson were held

constant in this research investigation, for the intent was to isolate the visual aesthetic as part of

participants' computer-based learning experiences.

5.9   Conclusion

In today's world of online digital multimedia, advances in technology and technological devices now allow for alternative experiences that can serve as a fairly adequate proxy to face-to-face interactions when real humans are either not available or not feasible. This includes the way students learn. Twenty-first century educational practices and offerings include pedagogical options that allow students to learn with stand-alone computer-based instruction (e.g., educational websites, museum kiosks, apps for mobile devices, etc.).

However, given the absence of human instructors to guide students in their thinking as they engage in a given task, there now exists the need to investigate methods through which computerized instruction may be optimized to help ensure effective and successful learning, in spite of the absence of human instructors. This includes more than a functioning, well-organized, and usable learning program. Without thoughtful design, students' levels of motivation to learn and thus how well they learn are at risk. The process of learning is an entire 'experience,' and it is imperative that students feel that the impending educational experience will be one worth having, from the very beginning and onward…and every experience begins with the first impression.

To gain a better understanding of the first impression as it relates to successful online learning, this research (1) investigated just what constitutes students' impressions of an impending educational task via the measurement of this construct and (2) examined how manipulations designed to elicit differing initial perceptions about what is essentially the same task might affect elements of the learning process with respect to the task: students' first

impressions, the formation of expectancies and task values, their achievement-related choices, and finally how well they actually learned with the task.

The first major goal was addressed via the creation and development of a new scale, *Impressions of the Task*. By capturing various perceptions a student might have with respect to a computer-based, educational task's quality characteristics, the scale successfully measures a students' overall impressions regarding the task at hand while providing a means for understanding in greater detail just what constitutes the impressions students may form about a task. Tests of reliability and validity support the scale's viability as an instrument for measuring this construct. In addition to perceptions regarding the quality characteristics of a given task, exploratory factor analysis revealed three underlying dimensions of the *Impressions of the Task* construct: *Social Experience, Caliber,* and *Demands on the Learner*. These findings provide researchers, designers, and educators with additional insight and a more meaningful way through which to measure the engineering and makeup of students' impressions of educational tasks.

The second major goal of this research was addressed by way of an experimental study in which two modes of impression formation were manipulated via changes in the way the task was presented to students: verbal (written) information pertaining to task quality and the website's aesthetic design. Findings from this (quasi-) experimental study contribute to the existing literature base on impression formation and digital learning in the following ways:

First, by addressing both first impression factors together within the same study, this research uncovered an interaction effect that exists between the two. It was hypothesized that exposing learners to favorable conditions from both factors would positively affect students' learning outcomes, whereas exposing learners to unfavorable conditions from both factors would negatively influence learning outcomes from the task. The study yielded results that suggest a

more complicated picture. Whether the hypotheses were supported depended on the website's aesthetic design. Learning outcomes for students using the Embellished version of the site were as expected and aligned with research findings by Fries, Hors, and Haimerl (2006). Learning outcomes for students using the Basic design were unexpected and require additional research in order to obtain a better understanding of the results. In any case, findings demonstrate the intricacies involved regarding the influence of multiple contextual influences with respect to an educational task and how it is received.

Second, this study examined the first impression effect with respect to the expectancy-value theory of achievement motivation (Eccles et al, 1983; Wigfield & Eccles, 1992, 2000; Eccles & Wigfield, 2002), which includes constructs that speak to achievement motivation such as students' perceptions about the task, their expectancies relative to the task, and the ways in which students place value on doing the task. Because it aims to explain why students would want to do a given task, it provided an excellent framework in which to situate the questions posed by the current research. Findings from this investigation add to the expectancy-value literature base through the application this theory as part of experimental research, which had not yet been done. Additionally, it examined the constructs of the expectancy-value model with respect to 'the particular situation' versus the 'domain of study at large.' Both are described in the literature as being 'task-specific' instances when examining students' levels of achievement motivation, but work exploring this theoretical framework up until this point has focused on 'the task' at the much larger grain size of 'domain of study'(e.g., majoring in English). The current investigation departed from past work by providing a first look at Eccles and Wigfield's expectancy-value theory of achievement motivation in terms of *situation-specific* tasks, such as an in-class assignment to use an educational website to prep for a quiz.

Third—and in alignment with expectancy-value theory—this research took students'

individual characteristics into account when examining for the possible effects that

manipulations to the presentation of the task might have on motivation and learning. As

discussed in Chapter 2, students with differing levels of prior knowledge and individual interest

in a subject area tend to exhibit different behaviors and learning outcomes with respect to the

computer-based task (Barab, Bowdish, & Lawless, 1997; Carmel, Crawford, & Chen, 1992;

Dimopoulos & Asimakopoulos, 2010; Lawless & Kulikowich, 1996; Lawless, Schrader, &

Mayall, 2007; Recker, 1994; Schrader, Lawless, & Mayall, 2008;). In conjunction with the

experimental conditions of the task and the various outcome variables targeted for examination,

this research acknowledged how differing levels of prior knowledge and individual interest can

also influence the learning process.

Finally, there is a paucity of research that examines impression formation with respect to

actual measures of learning. This research investigation not only examined students' learning

outcomes; it examined them with respect to the quality of learning—surface level versus deep

level processing. Based on results from the pilot study for this research (Manning, Lawless, &

Mayall, 2011), students assigned to favorable conditions were hypothesized to process the

educational website's content information more deeply than students assigned to unfavorable

conditions. Results from the current study, however, show significant differences in student

performance on assessment items requiring surface level processing (as opposed to deep level).

These contrasting results beg for further investigation into what aspects of the educational

situation (e.g., peripheral cues) are influential over depth of processing and why.

Together, the results of this research investigation demonstrate the need for future

research in this area. While it is clear that a website's visual aesthetics play a role in students'

thoughts and actions throughout the process of learning, the influence of verbal information during the learning process is still unclear. Additionally, results regarding students' post-activity knowledge brought about new questions in need of answers. This research is but a first step in the process of uncovering the 'do's and don'ts' of impression management for stand-alone digital learning. More must be done in order to understand, design, and provide educational experiences that ensure genuine engagement and high-quality learning for 21st century learners.

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APPENDICES

APPENDIX A

Individual Interest

Instructions: In the following set of items, you will find a number of statements related to science. Please indicate in each case to what extent these statements are true for you.

* = Indicates items to be reverse coded

Use Likert-type scale for the following. Response options are as follows:

- highly disagree
- disagree
- somewhat disagree
- somewhat agree
- agree
- highly agree

Feeling-related valences
1) Working with genetics subject matter is not really among my favorite activities.*
2) I don't like to talk much about genetics.*
3) Being involved with genetics puts me in a good mood.
4) Much of the time, genetics don't mean anything to me.*

Value-related valences
5) It is of great personal importance to me to be able to learn about genetics and genetics-related subject matter.
6) To be absolutely honest, I feel sometimes rather indifferent toward the study of genetics.*
7) Genetics has, in fact, very little to do with my self-realization.*
8) Compared to other things that are of great importance to me (e.g., hobbies, social life), understanding genetics is of markedly less significance to me.*
9) Regardless of the paths I've chosen in life, having genetics knowledge is important to me.
10) I'm certain that studying genetics has a positive influence on me as a person.

Intrinsic orientation
11) If I had enough time, I would do more to learn about certain genetics topics, even if they had nothing to do with any of my coursework or professional pursuits.
12) Genetics corresponds with my personal preferences regarding areas of study.
13) I voluntarily spend time thinking about genetics-related subject matter (e.g., read books, watch science-related programming on television, read about it in the news or on the Web, have conversation with others).
14) I like genetics because of the interesting subject matter involved.

APPENDIX B

Prior Knowledge

Please respond to the following items by circling the ONE best answer for each item.

1. *Human cells* have at least two _____ for each gene, one from the mother and one from the father.
        a. mutations
        b. alleles
        c. chromosomes ✔
        d. proteins

2. Two nucleotide sequences found in two different species are almost exactly the same. This suggests that these species
        a. are evolving into the same species.
        b. contain identical DNA structures.
        c. may have similar evolutionary histories. ✔
        d. have the same number of mutations.

3. A molecule of DNA is a polymer composed of
        a. glucose.
        b. amino acids.
        c. fatty acids.
        d. nucleotides. ✔

4. The presence of DNA is important for cellular metabolic activities because DNA
        a. directs the production of enzymes. ✔
        b. is a structural component of cell walls.
        c. directly increases the solubility of nutrients.
        d. is the major component of cytoplasm.

5. Mendel's discovery that characteristics are inherited due to the transmission of hereditary factors resulted from his
        a. careful microscopic examinations of genes and chromosomes.
        b. dissections to determine how fertilization occurs in pea plants.
        c. breeding experiments with many generations of fruit flies.
        d. analysis of the offspring produced from many pea plant crosses. ✔

6. Which structure includes all of the others?
        a. nucleolus
        b. nucleus ✔
        c. chromosomes
        d. genes

7. Most cell membranes are composed principally of
        a. DNA and ATP.
        b. proteins and lipids. ✔
        c. chitin and starch.
        d. nucleotides and amino acids.

8. Variations within a species are most likely the result of
        a. mutations and sexual reproduction. ✔
        b. synapsis and disjunction.
        c. mitosis and asexual reproduction.
        d. overpopulation and recombination.

APPENDIX B (continued)

9. All of the genes and other DNA of an organism is called its
    a. open reading frame.
    b. genome. ✓
    c. intron.
    d. multigene family.

10. Why was the first genome sequence considered a milestone?
    a. It found that viruses contained nucleic acids.
    b. It proved that DNA could be isolated from a virus.
    c. It showed the coding sequences for all the proteins produced by a virus.
    d. It proved that the coding sequences within a genome could be located and identified. ✓

11. How many genes constitute the human genome?
    a. more than 1 million
    b. about 3,500
    c. about 30,000 ✓
    d. about 46

12. The study of the molecular organization of genomes, their information content and the gene products they encode
    a. genetics.
    b. genomics. ✓
    c. ergonomics.
    d. bio-informatics.

13. What is a clone?
    a. The genetic identical twin of the surrogate mother, with her personality, character, intelligence, and talents.
    b. The genetic identical twin of the donor, with his own personality, character, intelligence, and talents. ✓
    c. The genetic identical twin of the donor, including his personality, character, intelligence, and talents.
    d. The genetic identical twin of the surrogate mother, with his own personality, character, intelligence, and talents.

APPENDIX C

Impressions of the Task

Based on the screenshots of the educational website below, now indicate your level of agreement with each of the following statements that appear at the top of this screen.

1. **This looks like a good quality educational website about genetics.**

Highly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Highly Agree

2. **This educational website looks enjoyable to use.**

Highly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Highly Agree

3. **This educational website looks like it will be effective at helping me to learn about genetics.**

Highly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Highly Agree

4. **This web-based lesson looks like a trustworthy resource for learning.**

Highly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Highly Agree

5. **By the looks of it, I will have to work really hard in order to learn about genetics with this website.***

Highly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Highly Agree

6. **This educational website looks highly interactive.**

Highly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Highly Agree

7. **This educational website looks difficult for me to learn with.***

Highly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Highly Agree

8. **This educational website looks like it contains good quality learning content.**

Highly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Highly Agree

APPENDIX C (continued)

9. **By the looks of it, this educational website probably has outdated information.***

Highly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Highly Agree

10. **This educational website looks like it will communicate information in a way that I can understand.**

Highly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Highly Agree

11. **This educational website is attractive.**

Highly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Highly Agree

APPENDIX D

Expectancies for the Task
and Task Values

For this last set of items, read each statement and then mark the most appropriate response based on what you think and feel.

Under each statement, choices are horizontally listed from left to right.

Example:

    ◯   ◯   ◯   ◯   ◯   ◯   ◯

not at all   very

Items measuring *Expectancies for the Task*:

1. I will do well at learning about genetics with this website.
2. Compared to other students, how well do you expect to do at learning genetics info/concepts with this educational website?
3. I will probably get a good score on the genetics assessment at the end of this task.

Items measuring *Task Values*:

- **Intrinsic Value**
    1. I look forward to learning about genetics with this website.
    2. Learning about genetics with this website will be interesting.
    3. I will like using this website to learn about genetics.

- **Utility Value**
    1. The information found in this website is the kind of knowledge that is useful to have.
    2. How useful do you think the information in the website will be for what you want to do after you graduate and go to work?
    3. How useful is what you can learn from this website to your life?

- **Attainment Value**
    1. For me, doing a good job at learning about genetics with this website is important.
    2. How important is it for you to do well on the genetics assessment at the end of this task?
    3. Is the effort it will take to learn about genetics with this website worthwhile to you?

- **Relative Cost**
    1. To do well at learning about genetics with this website, I will have to work harder than I do when learning about other subject areas.
    2. The thought of learning about genetics with this website and then taking an assessment afterward makes me nervous.

APPENDIX E

Topic Knowledge

Instructions: The following items are a knowledge assessment based on the genetics website you just used. Please respond to the following items by circling the ONE best answer for each item.

Classical (Mendelian) Genetics

1. *(surface)* To determine the phenotype of a cat:
    a. **Look at the cat** ✓
    b. Look at the cat's parents
    c. Cross the cat with a homozygous dominant cat
    d. Cross the cat with any cat of the opposite sex

2. *(surface)* In an organism with the Bb genotype, the characteristic of the trait that does not show up is called:
    a. hybrid
    b. **recessive** ✓
    c. weak
    d. skipped

3. *(deep)* In a cross between brown mice and white mice, only white offspring are produced. This is an example of Mendel's Law of:
    a. Independent Assortment
    b. Segregation
    c. Incomplete Dominance
    d. **Dominance** ✓

4. *(deep)* How can two organisms have the same phenotype but different genotypes?
    a. One is homozygous dominant, and the other is homozygous recessive.
    b. Both are homozygous for the dominant trait.
    c. **One is heterozygous, and the other is homozygous dominant.** ✓
    d. Both are heterozygous for the dominant trait.

5. *(surface)* How many alleles usually determine a trait?
    a. 1
    b. **2** ✓
    c. 3
    d. 4

APPENDIX E (continued)

6. *(deep)* To determine the genotype of a red mouse, cross the mouse with:
   a. A homozygous red mouse
   b. A heterozygous red mouse
   c. A hybrid red mouse
   d. A homozygous beige mouse ✓

7. *(deep)* A cross between purple petunias and white petunias produces 100 offspring, all blue. This is an example of:
   a. Codominance
   b. Dihybrid segregation
   c. Incomplete Dominance ✓
   d. Independent Assortment

Patterns of Inheritance

8. *(surface)* The removal of paired, homologous chromosomes from the nucleus of a cell and their arrangement in decreasing size order is known as:
   a) a pedigree
   b) a genome
   c) blood screening
   d) a karyotype ✓

9. *(surface)* A person with which blood type can donate blood to anyone?
   a. A
   b. B
   c. AB
   d. O ✓

10. *(deep)* A couple has four children, and each child has a different blood type. What is the genotype of the parents?
   a) $I^A I^A$ and $I^A i$
   b) $I^A I^B$ and $I^B i$
   c) $I^A i$ and $I^B i$ ✓
   d) $I^A I^B$ and ii

APPENDIX E (continued)

11. *(deep)* A man with type A blood is married to a woman with type B blood. How is it possible that they have a child with type O blood?
   a) Both parents are homozygous for their blood type
   b) Both parents are heterozygous for their blood type ✓
   c) The father is homozygous for type A blood, and the mother is heterozygous for type B blood.
   d) The father is heterozygous for type A blood, and the mother is homozygous for type B blood.

12. *(deep)* A color-blind man can transmit the sex-linked allele for his disease to:
   a) His daughters only ✓
   b) His sons only
   c) Both his sons and daughters
   d) 50% of his male children

13. *(surface)* A *carrier* can best be defined as:
   a) A female who has two alleles for a genetic disease
   b) A male who has an allele for a disease and has (manifests) the disease
   c) A female who has an allele for a disease but does not have (does not manifest) the disease ✓
   d) A male who has two sex-linked chromosomes for a genetic disease

APPENDIX F

Point of Comparison Check

Show both versions of interface design (plus sample content screens), side by side. The version students used should appear on the right; the alternate version they did NOT use will appear on the left.

Instructions for user (bolded below):

There were actually two versions of the visual design for this website, shown below. Please compare the two of them and then rate each (after having a chance to see the alternate interface design).

Now that you have seen both versions of the interface visual design for the website, please indicate your opinion about each in the items below.

For each version of the sample content screens, the user will complete the two items below:

1. This website design is attractive.

  ○   ○   ○   ○   ○   ○   ○
not at all   very

2. This website design is professional-looking.

  ○   ○   ○   ○   ○   ○   ○
not at all   very

APPENDIX G

Demographics

Instructions for user (bolded below):
Please respond to the following items.

1. **You are:**
   a) An education student specializing in science instruction
   b) An education student who plans to teach most subject areas
   c) None of the above

2. **Select the highest level of biology coursework you have taken out of the following choices:**
   a) High school Biology
   b) College-level General Biology (or AP Biology)
   c) College-level Biology course(s) beyond General Biology

3. **Select the highest level of chemistry coursework you have taken out of the following choices:**
   a) High school Chemistry
   b) College-level General Chemistry (or AP Chemistry)
   c) College-level Chemistry course(s) beyond General Chemistry

4. **What grade do you typically earn in science courses you have taken?**
   a) A
   b) B
   c) C
   d) D
   e) F

5. **What is your class status?**
   a) freshman
   b) sophomore
   c) junior
   d) senior
   e) graduate student

6. **Your gender:**
   a) male
   b) female

VITA

Flori H. Manning

Education

University of Illinois at Chicago

Ph.D., Educational Psychology, 2014
Dissertation*: On Leveraging the First Impression: Learning, Achievement Motivation, and the Design of Digital Tasks*

M.Ed., Measurement, Evaluation, Statistics, & Assessment (MESA), 2010

Illinois Institute of Art

B.F.A., Interactive Media Design, 2005

Professional Certification

Certified Usability Analyst (CUA) – Human Factors International, License #2012-3741

Professional Experience: Research & Design

Principal Investigator, August 2008 - Present
Impression Formation, Expectancies, Values, and Achievement Motivation for Digital Tasks
Department of Educational Psychology, University of Illinois at Chicago
> Research examining impression formation with respect to digital learning environments (based on the design and presentation of information) and its influence on users' attitudes, the nature of their experiences, and ultimately the quality of learning that results

Graduate Research Assistant, August 2006 – August 2011
Digital Literacy Assessment
Learning Sciences Research Institute, University of Illinois at Chicago
> Research activities under the direction of Principal Investigator Dr. Kimberly A. Lawless and Co-Principal Investigators Dr. Susan R. Goldman, Dr. Kimberley Gomez, and Dr. Jim Pellegrino

Instructional Designer & Project Manager, June 2005 – July 2006
Centrax Corporation, Chicago, IL
> Instructional design and development of e-Learning software for corporate education and training. Project management and client relations; user experience design; information architecture and content development.

VITA (continued)

Professional Experience: Instruction

Adjunct Professor, ED 210: The Psychology of Learning & Instruction
College of Education, University of Illinois at Chicago
Fall & Spring Semesters 2012-2013
Fall & Spring Semesters 2011-2012
Fall & Spring Semesters 2010-2011

Adjunct Professor, ED 352: Integrating Technology into Elementary Schools
College of Education, University of Illinois at Chicago
Fall Semester 2009

Teaching Assistant, EPSY 503: Essentials of Quantitative Analysis in Education
College of Education, University of Illinois at Chicago
Spring Semester 2010

Workshop Instructor, July 2008
Teachers Infusing Technology into Urban Schools (TITUS) Summer Institutes
College of Education, University of Illinois at Chicago
    Conducted workshops on the utilization of learning technologies for in-service Chicago
    Public School teachers

Dance Instructor, November 2001 – June 2005
Latin Street Dancing, Inc., Chicago, IL
    Course development and Latin dance instruction for adults and teens, from beginning to
    advanced-level classes

Publications

Goldman, S. R., Lawless, K. A., & Manning, F. H. (2013) Research and development of multiple
       source comprehendsion assessment. In M. A. Britt, S. R. Goldman, & J. F. Rouet (Eds.),
       Reading: From Words to Multiple Texts. New York: Routledge, Taylor & Francis.

Lawless, K. A., Goldman, S. G., Gomez, K. W., Manning, F. H., & Braasch, J. L. G (2012).
       Assessing multiple source comprehension through evidence centered design. In J.
       Sabatini & E. R. Albro (Eds.), *Assessing reading in the 21st century: Aligning and
       applying advances in the reading and measurement sciences*. Lanham, MD: Rowman &
       Littlefield Publishing.

VITA (continued)

Manning, F. H., & Lawless, K. A. (2011). First impressions of an educational website: The relationship between student attributes and visual preferences for the digital learning environment. *Journal of Interactive Learning Research, 22*(1), 51-83.

Goldman, S. R., Lawless, K. A., Pellegrino, J., Braasch, J., Manning, F. H., & Gomez, K. W. (2011). A technology for assessing multiple source comprehension: An essential skill of the 21st century. In M. Mayrath, J. Clarke-Midura, & D. H. Robinson (Eds.), *Technology-Based Assessments for 21st Century Skills: Theoretical and Practical Implications from Modern Research*. Charlotte, NC: Information Age Publishing.

Goldman, S. R., Ozuru, Y., Braasch, J. L. G., Manning, F. H., Lawless, K. A., Gomez, K. W., & Slanovitz, M. (2010). Literacies for learning: A multiple source comprehension illustration. In N. L. Stein & S. Raudenbush (Eds.), *Developmental Cognitive Science Goes to School.* New York: Taylor & Francis. OR: *Developmental science goes to school: Implications for policy and practice* (pp. 30-44). New York, NY: Routledge.

Braasch, J. L. G., Lawless, K. A., Goldman, S. R., Manning, F. H., Gomez, K. W., & MacLeod, S. (2009). Evaluating search results: An empirical analysis of middle school students' use of source attributes to select useful sources. *Journal of Educational Computing Research, 41*(1), 63-82.

Goldman, S. R., Lawless, K. A., Gomez, K. W., Braasch, J. L. G., MacLeod, S., & Manning, F. H. (2009). Literacy in the digital world: Comprehending and learning from multiple sources. In M. C. McKeown & L. Kuncan (Eds.), *Bringing Reading Research to Life*. New York: Guilford Publications.

Manning, F. H., Goldman, S. R., Ozuru, Y., Lawless, K. A., Gomez, K. , & Braasch, J. L. G. (2008). Students' analysis of multiple sources for agreements and disagreements. In G. Kanselaar, V. Jonker, P. A. Kirschner, & F. J. Prins (Editors), *International perspectives in the Learning Sciences: Cre8ing a learning world: Proceedings of the Eighth International Conference of the Learning Sciences – ICLS 2008*, (Volume 2, pp. 19-26.). Utrecht, The Netherlands: International Conference of the Learning Sciences (www.isls.org). Printed proceedings printed and distributed by: Lulu (www.lulu.com).

Lawless, K. A., Braasch, J., Manning, F. H., Goldman, S., Ozuru, Y., & Gomez, K. (2008). Assessment of digital literacies: Initial task design and piloting of a source selection module. In G. Richards (Ed.), *Proceedings of the World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education, Vol. 2008, Number 1*, pp. 2880-2885. Chesapeake, VA: AACE

VITA (continued)

National and International Refereed Conference Presentations

Manning, F. H., Lawless, K. A., & Goldman, S. R. (2012, April). *Students determining the usefulness of multiple sources: Evaluating search results in social studies and science.* Paper accepted for presentation at the annual meeting of the American Educational Research Association, Vancouver, Canada.

Manning, F. H., Lawless, K. A., & Mayall, H. J. (2011, April). *Student perceptions of a web-based lesson: Interface aesthetics and learning outcomes.* Paper presented at the annual meeting of the American Educational Research Association, New Orleans, LA.

Richards, K., Manning, F. H., Goldman, S. R.., Lawless, K. A., Penzick, R., & Doherty, R. (2011, April). *Toward an instructional framework that supports reading comprehension of multiple sources of texts.* Paper presented at the annual meeting of the American Educational Research Association, New Orleans, LA.

Manning, F. H., Lawless, K. A., Goldman, S. R., & Braasch, J.L.G. (2011, April). *Evaluating the usefulness of multiple sources: Middle school students' analysis and ranking of Internet search results with respect to an inquiry question.* Poster presented at the annual meeting of the American Educational Research Association, New Orleans, LA.

Goldman, S. R., Lawless, K. A., Manning, F. H., Richards, K., Braasch, J. (2011, April) Assessment designs for 21st century literacies. Poster presented at the annual meeting of the American Educational Research Association, New Orleans, LA.

Goldman, S. G., Lawless, K. A., Gomez, K. W., Braasch, J. L. G., Manning, F. H., Ozuru, Y., & Richards, K. (2010, August). *Assessment of Multiple Source Comprehension.* Paper presented at the Annual Meeting of the Society for Text and Discourse, Chicago, IL.

Braasch, J. L. G., Lawless, K. A., Manning, F. H., Goldman, S. R., & Ozuru, Y. (2010, May). *Assessing middle grade students' ability to evaluate search engine results.* Poster presented at the annual meeting of the American Educational Research Association, Denver, CO.

Goldman, S. R., Ozuru, Y., Slanovits, M., Richards, K., Lawless, K. A., Gomez, K. W., Manning, F. H., & Braasch, J. L. G. (2010, May). *Analysis and synthesis of information from multiple texts.* Poster presented at the annual meeting of the American Educational Research Association, Denver, CO.

Manning, F. H., Goldman, S. R., Ozuru, Y., Lawless, K. A., Gomez, K. W., & Braasch, J. L. G. (2009, August). *Middle school students' synthesis of information from multiple sources.* Poster presented at the annual meeting of the American Psychological Association, Toronto, Ontario Canada.

Goldman, S. R., Gomez, K. W., Lawless, K. A., Ozuru, Y., Manning, F. H., & Slanovitz, M. (2009, August). *Young adolescents' approach to multiple source comprehension analysis and synthesis tasks.* Paper presented at the 13th biennial conference of the European Association of Research on Learning and Instruction, Amsterdam, the Netherlands.

Manning, F. H., & Lawless, K. A. (2009, May). *Learner attributes and visual preferences for the Web-based learning experience.* Poster presented at the annual meeting of the Association of Psychological Science, San Francisco, CA.

Lawless, K. A., Braasch, J., Manning, F. H., Goldman, S., Ozuru, Y., & Gomez, K. (2008, November). *Assessment of digital literacies: Initial task design and piloting of a source selection module.* Paper presented at the annual E-Learn conference, Las Vegas, NV.

Goldman, S. R., Slanovits, M., Ozuru, Y., Gomez, K., Lawless, K. A., Braasch, J. L. G., Manning, F. H., & Perelman, L. (2008, July). *Identifying causes of historical events: The role of text and task interactions.* Paper presented at the Annual Meeting of the Society for Text and Discourse, Memphis, TN.

Braasch, J. L. G., Lawless, K. A., Ozuru, Y., Goldman, S. R., Gomez, K. W., Manning, F. H., & Slanovits, M. (2008, July). *Inquiry in science: An empirical analysis of college students' use of source attributes to select useful sources.* Paper presented at the Annual Meeting of the Society for Text & Discourse, Memphis, TN.

Manning, F. H., Goldman, S. R., Ozuru, Y., Lawless, K. A., Gomez, K. , & Braasch, J. L. G. (2008, June). *Students' analysis of multiple sources for agreements and disagreements.* Paper presented at the International Conference of the Learning Sciences, Utrecht, the Netherlands.

Manning, F. H., Lawless, K. A., Gomez, K. W., MacLeod, S., Braasch, J. L. G., & Goldman, S. R. (2008, May). *Sources of information in the classroom: Characterizing instruction through a model of multiple source comprehension for inquiry-based learning.* Poster presented at the annual meeting of the Association for Psychological Science, Chicago, IL.

VITA (continued)

Braasch, J. L. G., Lawless, K. A., Goldman, S. R., Manning, F. H., Gomez, K. W., & MacLeod, S. (2008, March). *Inquiry in social studies: An empirical analysis of middle school students' use of source attributes to select useful resources.* Paper presented at the annual meeting of the American Educational Research Association, New York, NY.

Goldman, S. R., Lawless, K. A., Gomez, K. W., Bertenthal, M., Braasch, J. L. G., MacLeod, S., Manning, F. H., Fujimoto, K., & Manderino, M. (2007, April). *Assessing multiple-source digital literacy skills.* Symposium paper in honor of Michael Pressley presented at the annual meeting of the American Educational Research Association, Chicago, IL.

Invited Presentations & Guest Lectures

Manning, F. H., Lawless, K. A., & Mayall, H. J. (2011, March). *Student perceptions of a web-based lesson: Interface aesthetics and learning outcomes.* Learning Sciences Colloquium, Learning Sciences Research Institute, University of Illinois at Chicago, Chicago, IL.

Richards, K., Manning, F. H., Goldman, S. R.., Lawless, K. A., Penzick, R., & Doherty, R. (2011, March). *Toward an instructional framework that supports reading comprehension of multiple sources of texts.* Learning Sciences Colloquium, Learning Sciences Research Institute, University of Illinois at Chicago, Chicago, IL.

Manning, F. H., & Lawless, K. A. (2009, November). *Do looks matter? Interface aesthetics and educational outcomes from a Web-based lesson.* E-Learning Design II course (IMD 370), Department of Interactive Media Design, Illinois Institute of Art, Chicago, IL.

Manning, F. H., Gopalan, S., Gorski, J., & Pacifici, S. (2009, August). *Light me up! The development of a participatory simulation to facilitate students' collaborative exploration of color perception concepts in the classroom.* Multimedia Systems course (CS 523), Department of Computer Science, University of Illinois at Chicago, Chicago, IL.

Manning, F. H. (2009, November). *Social media in digital learning.* E-Learning Design II course (IMD 370), Department of Interactive Media Design, Illinois Institute of Art, Chicago, IL.

Manning, F. H. (2009, November). *Process and execution of the E-learning project.* E-Learning Design II course (IMD 370), Department of Interactive Media Design, Illinois Institute of Art, Chicago, IL.

VITA (continued)

Academic & Professional Honors

Recipient, Presenter Award, 2011-2012
The UIC Graduate College's Presenter Award is intended to help selected applicants defray costs associated with presenting original research at scholarly meetings or conferences.
Award: $200

Recipient, Presenter Award, 2010-2011
The UIC Graduate College's Presenter Award is intended to help selected applicants defray costs associated with presenting original research at scholarly meetings or conferences.
Award: $200

Recipient, Presenter Award, 2009-2010
The UIC Graduate College's Presenter Award is intended to help selected applicants defray costs associated with presenting original research at scholarly meetings or conferences.
Award: $200

Recipient, Presenter Award, 2008-2009
The UIC Graduate College's Presenter Award is intended to help selected applicants defray costs associated with presenting original research at scholarly meetings or conferences.
Award: $200

Participant, AERA 2009 Division C Graduate Student Seminar
The objective of this seminar is to provide promising graduate students with an opportunity to receive mentoring, advice, and the development of professional relationships with current leaders in the field. Competitive selection process, with only the top 30% of applicants invited to attend.
Stipend: $350

Graduate Speaker, Illinois Institute of Art Commencement Ceremony, June 2005
Selected by my undergraduate institution to be the student representative and voice of the graduating class of 2005

Service

Ad hoc reviewer:
Journal of Educational Computing Research
Journal of Experimental Education (Student Reviewer)

Conference proposal reviewer:
International Conference of the Learning Sciences (ICLS)
American Educational Research Association (AERA)

VITA (continued)

Professional Affiliations

American Educational Research Association (AERA)
Association for Psychological Science (APS)
American Psychological Association (APA)
International Society for Technology in Education (ISTE)
Association for Educational Communications and Technology (AECT)

Technology

SPSS (Statistical analysis)
Adobe Captivate, TechSmith's Camtasia Studio (Record and edit computer onscreen activity)
Adobe Flash, Adobe Dreamweaver (Website animations, interactivity, layout)
Adobe Photoshop, Adobe Illustrator (Digital image creation and manipulation)
Adobe Soundbooth, Sony Sound Forge, Audacity (Sound editing)
HTML, CSS, Actionscript (Scripting Languages)