THE ROLE OF UTILITY VALUE IN THE DEVELOPMENT OF INTEREST AND ACHIEVEMENT

by

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Dedication

To Teresa – Without your sacrifices this endeavor would not have been possible. You have made this experience more meaningful because I was able to share it with you, and you have improved the quality of my work because you make me want to be a better scientist.

To our children – May you have grand visions and the motivation to make them come alive.

To our parents – Thanks for your support; I hope I have made you proud.

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THE ROLE OF UTILITY VALUE IN THE DEVELOPMENT

OF INTEREST AND ACHIEVEMENT

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In this dissertation, I evaluate whether helping students see the value in their coursework contributes to interest and achievement. Part 1 describes two studies that test the effectiveness of an instructional intervention to promote perceptions of utility value and interest – particularly for students with lower competence beliefs. Part 2 extends these findings by testing a long-term intervention with high school students, and then examining the motivational processes that account for the effects of the intervention. A process model of utility value effects is proposed and tested. The results demonstrated that the intervention effectively increased perceptions of utility value and interest. In addition, the hypothetical pathways of the process model were supported. Implications for research and practice are discussed.

The Role of Utility Value in the Development of Interest and Achievement

"Things indifferent or even repulsive in themselves often become of interest because of assuming relationships and connections of which we were previously unaware. Many a student…has found mathematical theory, once repellent, lit up by great attractiveness after studying some form of engineering in which this theory was a necessary tool." (Dewey, 1913, pp. 22)

John Dewey describes how finding the value and relevance in an activity can elicit interest and energize behavior. His assertion is supported by research evidence that links interest with: a) performance (Schiefele, Krapp, & Winteler, 1992), b) psychological processes associated with learning (Hidi, 1990), and c) future academic choices such as course enrollment and college major (Harackiewicz, Barron, Tauer, Carter, & Elliot, 2000). Unfortunately, the research literature on student motivation has evidenced an alarming trend: interest in school tends to decrease over time, with students with lower competence beliefs reporting lower interest and motivation than students with higher competence beliefs (Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002; Lepper, Corpus, & Iyengar, 2005). Thus, declining interest could also mean declining performance and commitment to school. What can be done about this downward trajectory of student interest, particularly for less competent students?

In this dissertation, I evaluate whether helping students see the value in their coursework can contribute to both interest and achievement. Part 1 of the dissertation research describes two studies that test the effectiveness of an instructional intervention to promote perceptions of utility value and interest – particularly for students with lower competence beliefs. Part 2 of the dissertation research extends these findings by testing a long-term intervention with high school students, and then examining the motivational processes that account for the effects of the intervention. The utilization of randomized experiments in my dissertation research complements my previous research on the relationship between utility value and learning outcomes, which was primarily correlational (Hulleman, Durik, Schweigert, & Harackiewicz, 2007). This combination of approaches creates a foundation from which we can make causal inferences regarding the effects of utility value.

The Development of Interest

Prior research has demonstrated that interest is associated with learning and learning processes such as attention (Hidi, 1990), the quality of learning and complexity of knowledge structures (Schiefele, 1991), levels of learning (Alexander & Murphy, 1998), and academic and laboratory performance (Ainley, Hidi, & Berndorff, 2002; Schiefele et al., 1992). Interest has also been associated with important achievement choices such as future course enrollment and choice of major (Harackiewicz, Barron, Tauer, Carter, & Elliot, 2000; Harackiewicz, Barron, Tauer, & Elliot, 2002; Harackiewicz, Durik, Barron, Linnenbrink, & Tauer, in press). Interest can be defined as a psychological state, e.g. "being engaged, engrossed, or entirely taken up with some activity (Dewey, 1913, p. 17)," and as a process that emerges over time (Hidi & Renninger, 2006). *Individual interest* has a dispositional quality that endures and may deepen over time (Renninger, 2000). In contrast, *situational interest* develops through an interaction between the individual and task features that stimulate engagement with the activity (Hidi & Baird, 1988). Situational interest that leads to reengagement with the activity over time can promote the development of individual interest.

Hidi and Renninger (2006) have proposed a four-phase model of interest development whereby interest in an activity is developed through an interaction between the individual and the activity. Their model considers both the interests that individuals bring to an academic setting (i.e., individual interest), and the development of interest in the absence of a pre-existing interest, such as the process described by Dewey whereby a seemingly dull topic may be brought to life in a particular context (i.e., situational interest). An example of interest developing through the four phases might go something like the following. As momentary interest in a specific situation is activated by some external cue (triggered situational interest: Phase 1), an individual may perceive value in the activity, and the desire to continue pursuing the activity may then deepen over time (maintained situational interest: Phase 2). If situational interest is maintained and an individual continues to engage in the activity and perceive value in it, then individual interest may begin to develop (emerging individual interest: Phase 3). Continuing re-engagement with the task over a period of time, along with increased knowledge and positive affect, can create an enduring interest in the activity (developed individual interest: Phase 4). Thus, the interest that develops or deepens in a particular context depends on the extent to which value, positive affect, and knowledge are experienced in relation to the activity (Hidi & Renninger, 2006; Mitchell, 1993).

From Situational to Individual Interest

An important issue that the Hidi and Renninger (2006) model addresses is the transition from situational interest, which relies heavily on the context, to individual interest, which is an enduring characteristic of the person. What situational and individual difference factors facilitate the development of interest – beyond a positive reaction to something in the environment to something more lasting, such as individual interest in a topic or activity?

Personal valuation of domain content, including topics and activities, is considered to be a key feature of developed situational interests (Durik & Harackiewicz, 2007; Harackiewicz, Barron, Tauer, & Elliot, 2002; Hidi & Harackiewicz, 2000; Hidi & Renninger, 2006; Krapp, 2002; Schiefele, 1991), along with the experience of positive affect (Hidi, 1990) and knowledge (Hidi & Renninger, 2006). In addition, the perception of value is hypothesized to be a key contributor in the progression from situational (Phase 2) to individual (Phase 3) interest, and to the deepening of existing individual interest (Hidi & Renninger, 2006).

For example consider Mary, a student in a high school geometry class. Her situational interest in geometry may be stimulated by an interesting classroom activity, such as working with three-dimensional models. Later in the same class period, the teacher might talk to the students about the importance of geometry in the field of engineering. Mary is interested in becoming an engineer, and this application of geometry arouses her curiosity. That evening she talks to her father, who is an engineer, about how he uses geometry in his job. In the coming weeks Mary continues to make connections between geometry and engineering, which serve to energize her engagement in the classroom. She begins to apply her knowledge of geometry outside of the classroom, and starts investigating college engineering programs using the internet. In this way, Mary's perception of personal value in geometry, due to its connection with her future goal of becoming an engineer, has fostered the development of an emerging individual interest. This type of value, where an individual perceives an activity to be relevant to her life, has been called utility task value, or utility value (Eccles & Wigfield, 2002; Simons, Vansteenkiste, Lens, & Lacante, 2004).

Task Values

A useful theoretical framework for understanding the role of task values in achievement contexts is the expectancy-value model (Eccles et al., 1983). It posits that perceived expectancies for success and task values determine choices of achievement tasks, as well as performance on these tasks. Expectancies for success are defined as individuals' beliefs about how well they will perform on an upcoming task. The task value construct is defined as perceived importance of the task and consists of three main components: intrinsic value, utility value, and attainment value. *Intrinsic value* is defined as the perceived importance of the task because it is enjoyable and fun to engage in. *Utility value* is defined as the perceived importance of an activity because of its usefulness for other tasks or aspects of an individual's life (e.g., perceiving geometry to be valuable because it applies to engineering). *Attainment value* is defined as the perceived importance of the task for the individual's self-concept, self-worth, and identity.

Intrinsic and utility value can be perceived almost immediately upon task engagement – during triggered situational interest (Hidi & Renninger, 2006) – and do not require prolonged exposure to the task. In the previous example of the geometry class, from the first day of class Mary could discover the enjoyment and relevance of geometry to her life. In contrast, in order for Mary to perceive attainment value in an activity (i.e., to determine that part of her self-definition that involves geometry), it will take time for her to incorporate geometry into her sense of self. In other words, attainment value can only be perceived after an individual has sufficient experience with the task. This distinction between situationally experienced task value (both intrinsic and utility) and internally identified task value (attainment) may prove to be critical in understanding the development of interest over time. Because it is a process that develops over time, identified task value is considered to be a consequence of situationally experienced task value. I discuss identified task value (i.e., attainment value) later in this section as one of the processes responsible for utility value effects. Next, I discuss the role of intrinsic and utility task values in the development of interest and performance in the classroom.

The importance of intrinsic value to the development of interest in tasks and activities is nearly self-evident: by its very definition intrinsic value is an inherent part of engaging in a task, and activities that have intrinsic value are intrinsically motivating (Csikszentmihalyi, 1990; Deci & Ryan, 1985; Eccles, 2005). Thus, it is not surprising to learn that there is a positive association between intrinsic value and measures of interest (Durik, Vida, & Eccles, 2006; Harackiewicz et al., in press; Hulleman, Durik et al., 2007; Updegraff, Eccles, Barber, & O'Brien, 1996). In contrast, it is less clear how utility value might contribute to the development of interest. Because of its connections to other tasks or activities, utility value has been described as being a more extrinsic type of value (Brophy, 1999; Hidi & Harackiewicz, 2000; Wigfield & Eccles, 1992). For example, the student of geometry may not be motivated because she finds solving geometry problems fun (i.e., intrinsic value), but because of the connection between geometry and engineering (i.e., utility value). Thus, engaging in the task is motivated in part by extrinsic reasons (Deci & Ryan, 1985). The extrinsic nature of utility value therefore presents a theoretical challenge to understanding how utility value might be related to interest development.

In fact, some theorists have reasoned that extrinsic motivation is antithetical to, or at best unrelated to, the development of individual interest in an activity (Deci & Ryan, 1985). A focus on extrinsic rewards tends to undermine interest and intrinsic motivation (Lepper, Greene, & Nisbett, 1973), particularly for interesting activities (Deci, Koestner, & Ryan, 1999). However, some researchers have suggested that there are multiple pathways to the development of interest and motivation (Hidi & Harackiewicz, 2000; Pintrich, 2000a), and that seemingly extrinsic factors may promote initial engagement in activities for some students – particularly those who are initially uninterested. Hidi and Renninger (2006) reason that, in the beginning, the development of interest must be initiated by the external context; that is, in the absence of a pre-existing interest something in the environment must draw our attention toward an activity. Once we are engaged with an activity we may find it to be intrinsically enjoyable, but the initial stimulation of interest and engagement must be externally instigated. Thus, perceiving utility value could serve to stimulate engagement for students who are initially indifferent to the activity by increasing its relevance to their lives or futures.

Utility Value and Learning Outcomes

Although originally conceptualized as a more extrinsic type of value (Eccles, et al., 1983; Eccles & Wigfield, 2002), utility value has been associated with outcomes that represent more intrinsically motivated behavior. For example, perceiving utility value in tasks has been found to predict important achievement choices, including course enrollment decisions (Durik et al., 2006; Meece, Wigfield, & Eccles, 1990; Updegraff et al., 1996; Wigfield, 1994), intentions to continue a school-based running program (Xiang, Chen, & Bruene, 2005), amount of free-time spent on sports and reading (Durik et al., 2006; Eccles & Harold, 1991), and interest (Hulleman, Durik, et al., 2007). In addition, there is some evidence that utility value may be related to achievement (Bong, 2001; Durik et al., 2006; Hulleman, An, Hendricks, & Harackiewicz, 2007;

Hulleman, Durik, et al., 2007; Mac Iver, Stipek, & Daniels, 1991; Simons, Dewitte, & Lens, 2004). For example, Hulleman, Durik et al. (2007) found that perceiving utility value in college course material early in the semester predicted interest at the end of the semester and final course grades. Thus, utility value may be of particular importance when attempting to understand both interest development and performance in educational settings (Simons, Vansteenkiste, Lens, & Lacante, 2004). However, because the majority of the research regarding utility value effects has been correlational, there is a need to establish the causal link between utility value and learning outcomes.

Causal Inference

Given this background, my research focuses on two questions of causal inference: 1) Can we increase students' perceptions of utility value in their coursework with an experimental intervention?, and 2) Will this intervention also increase student interest in the material? A model of these hypothetical effects is presented in Figure 1. Manipulations of utility value are expected to increase perceptions of utility value for an activity. In turn, these perceptions of utility value should lead to increases in interest and possibly performance. We often assume that there is a close correspondence between manipulated and perceived variables in an experiment; however, an exact correspondence is often difficult to achieve. It is an empirical question whether we can raise perceptions of value through a classroom intervention, and further, whether this manipulation of utility value affects interest in the same way that students' perceptions of utility value affects interest. The present research utilizes both randomized experiments and longitudinal surveys in order to assess the effects of manipulated and perceived utility value.

These research designs also position us to make causal inferences regarding the effects of utility value on interest and performance.

In addition, as educators we are interested in the impact we can have on our students' educational experience. As the Hidi and Renninger model (2006) suggests, the context of learning plays an important role in triggering initial interest, and in helping students reengage with the topic over time. In the classroom, the teacher plays a pivotal role in designing, implementing, and maintaining the quality of the classroom environment. The extrinsic nature of utility value may make it more amenable to situational interventions from teachers, parents, or others. The manipulation of utility value in these studies allows us to examine the impact of a specific curricular intervention on student motivation and learning. Thus, we can address the question: Can the teacher make a difference?

It is of particular importance to understand how educators can impact the motivation of students with low ability perceptions, because the downward trajectory of student interest in school is steeper for them (Jacobs et al., 2002). Below, I outline two possible ways that utility value and ability perceptions might interact to influence student motivation and learning. First, students who lack confidence in their ability may not perceive, or have a harder time perceiving, relevance and value in their schoolwork. Understanding a topic may be a necessary prerequisite for applying it elsewhere. For example, if a student is unable to understand geometry, then it may not be possible for him to understand how it applies to building roads and bridges (i.e., civil engineering). Second, perceiving value in a topic might actually help students with low confidence understand a topic. That is, perceiving the relevance of a topic may instigate learning processes before much is known about an activity. For example, a primary school teacher could present the task of memorizing basic multiplication facts as either something that “needs to be learned today”, or as a necessary skill for becoming an engineer or nurse. Through this connection the teacher may infuse the task with meaning and encourage students to become more engaged in their learning. As a result, the students may even see connections between what they are learning and important life goals (i.e., geometry and engineering), which could raise their interest in learning. In contrast, more confident students may not need this type of motivational boost because their interest and involvement in school subjects are already at a high level. One of the reasons that highly confident students do well might be that they already see value and meaning in their coursework. This line of thought raises several important issues addressed in my dissertation research.

First, how does manipulated utility value affect interest and performance? The research in my dissertation aims to replicate and extend prior correlational research by manipulating utility value. I expect utility value, whether it is manipulated or measured, to lead to the development of interest and improved performance. Second, what are the mechanisms whereby utility value has its effects? Hidi and Renninger (2006) propose that personal valuing, positive affect, and knowledge contribute to the development of interest. Thus, drawing from this theoretical perspective, utility value can play a role in interest development to the extent that the activity is personally relevant (i.e., by finding the activity to be helpful in achieving a personal goal), increases knowledge (i.e., by finding a new application for an activity), or is associated with positive affect (i.e., learning a new application for an activity can be empowering and create positive affect as it increases the possible actions that are relevant to the activity). In other words, it is possible that finding connections between an activity and real life infuses the material with meaning and value. This meaning and value could promote engagement in learning and identification with the activity (i.e., as connected with personally important goals). The involvement and identification with the activity may generate excitement, effort, interest, and enhanced learning and achievement.

Third, what is the most effective method for enabling students to perceive utility value? An obvious approach is to simply inform students of the possible connections between the material they are studying and their daily and future lives. However, will this approach be appealing to everyone? It is possible that some students might react negatively to being told that algebra is important for their future careers. For example, what if a student does not do well in algebra and becomes anxious in class because of his lack of skill? For this student, being told that algebra is important to his future may only serve to increase his anxiety about not doing well in algebra class. Rather than increase his engagement in the material, he may withdraw further from the learning environment. This hypothetical scenario has been supported by a recent study in our laboratory. Godes, Hulleman, & Harackiewicz (2007, Study 1) found that emphasizing the utility value of a math activity (e.g., “A nurse may use mental math computations to calculate medication amounts”) undermined subsequent interest for individuals with low perceptions of competence in math. In contrast, the utility manipulation boosted interest in the math activity for individuals with high perceptions of competence. In summary, simply informing students of the applications and relevance of an activity may not have universally beneficial effects.

An alternative approach would be to encourage students to generate their own applications and describe the relevance of the course material to their lives. This method provides students the opportunity to make connections to parts of their lives that interest them the most. For example, a student interested in sports could apply math to calculating the free throw percentages for her favorite players, whereas the student interested in nursing could apply his knowledge to calculating the correct dosage of medicine to give his patients. This approach might be particularly beneficial for students with low ability perceptions as it may avoid increasing anxiety as described earlier. Instead of withdrawing from the activity and becoming less interested, students with less confidence in their abilities might see a reason for becoming engaged and involved with their learning, and see the relevance of the course material to their future goals. Thus, allowing students to discover the connections between an activity and their lives on their own may be particularly beneficial for less confident students. I have incorporated these predictions for the effects of perceived ability into the model presented in Figure 2.

The solid paths from perceived ability to performance and perceived utility value indicate that students who expect to do well will indeed perform better, and are more likely to see the utility value in the material. The dotted path indicates that perceived ability will moderate the direct effect of manipulated utility value on perceived utility value. As discussed above, students with lower perceived ability might benefit more from a utility value intervention when they are encouraged to create the connections themselves. In contrast, students with higher ability perceptions may already be making connections with the material and this type of self-generated relevance may not have as pronounced of an effect for them.

Potential Mediators of Utility Value Effects

Motivation researchers have investigated several processes that could explain the effects of utility value on motivation. For example, perceiving the relevance of an activity to one's life or future goals may lead an individual to become more actively involved in learning, identify with the activity, and see its importance (Eccles & Wigfield, 2002; Malka & Covington, 2005; Miller, DeBacker, & Greene, 1999; Mitchell, 1993; Ryan & Deci, 2002; Simons et al., 2003). Mitchell (1993), based on the work of Dewey (1913), distinguished two components of holding situational interest: 1) involvement when engaging in an activity (i.e., "absorption"; Dewey, 1913), and 2) identification with the activity (i.e., "meaningfulness"; Mitchell, 1993). *Involvement* is defined as the extent to which an individual becomes involved and absorbed when doing an activity. *Identification* is defined as creating a personal connection between an activity and oneself. Mitchell (1993) hypothesized that both components would lead an individual to feel empowered as a learner; that is, "bestowing power for an end or purpose. For instance, making the content of learning meaningful for students tends to empower them because such a variable gives students more power to achieve their personal ends (Mitchell, 1993, p. 426)." Papert (1980) called this the "power principle" and suggested that good instruction will "empower the learner to perform personally meaningful projects that could not be done without it" (p. 54).

Perceiving utility value in a topic may promote active and involved task engagement. For example, perceiving a connection between geometry and life may energize an individual to become more actively involved in geometry class by seeking out learning opportunities, putting forth more effort, and becoming more engaged. When we are active contributors to the learning process we are likely to feel in control (deCharms, 1968; Deci, 1975), self-determined (Deci & Ryan, 1985), and efficacious (Bandura, 1997). This experience is similar to the qualities of flow, characterized by Csikszentmihalyi (1990) as an experience where action and awareness are merged and the individual experiences a sense of control. Similarly, Deci and Ryan (1985) describe autonomously regulated behavior, which involves feeling in control and efficacious in one's environment, as intrinsically enjoyable and motivating. In their process model of intrinsic motivation, Harackiewicz and Sansone (1991) proposed that becoming involved during task engagement is a precursor of intrinsic motivation. Rather than being a passive recipient of education, the student perceives that he is an active participant and becomes absorbed in the learning process. Research has demonstrated that feelings of involvement are associated with subsequent interest and performance on laboratory tasks (Harackiewicz, Barron, & Elliot, 1998; Barron & Harackiewicz, 2001; Durik & Harackiewicz, 2003) and with positive life outcomes such as happiness and academic performance (Csikszentmihalyi, 1990).

In addition, perceiving utility value in a topic may also lead to an increase in the importance of an activity, and eventually to the identification of the activity with the individual's self-concept. For example, finding an application for an activity (e.g., math and engineering) opens up the possibility of making connections to things that are personally important to the individual (e.g., a career as an engineer). Once these connections have been made, and the individual has incorporated the activity into her self-concept (i.e., identification), the individual may then become more interested in the activity, willing to seek it out over time, and focus attention and energy towards acquiring activity-related skills and knowledge. Because of the connection with the individual's self-concept, working on the task has become self-relevant. In other words, the identification process can play an important role in the development of individual interest (i.e., moving from Stage 2 to Stage 3; Hidi & Renninger, 2006). Identification has been investigated within other motivational theories under such labels as attainment value (Eccles & Wigfield, 2002), competence valuation (Harackiewicz & Manderlink, 1984; Harackiewicz, Sansone, & Manderlink, 1985), identified regulation (Deci & Ryan, 1985), perceived instrumentality (Miller, DeBacker, & Greene, 2000), hold (Dewey, 1913; Durik & Harackiewicz, 2007; Harackiewicz et al., 2000; Mitchell, 1993), and future time perspective (Husman & Lens, 1999). Research has demonstrated that identification is associated with effort, persistence, intrinsic motivation, and performance (Deci & Ryan, 2000; Malka & Covington, 2005; Miller, DeBacker, & Greene, 1999; Sheldon, 2002; Simons et al., 2003, 2004; Vansteenkiste, Lens, & Deci, 2006). For example, Malka and Covington (2005) surveyed college students about the relevance of the course material to their future (i.e., perceived instrumentality). They found that this type of identification with the material predicted end-of-semester grades above and beyond the effects of achievement goals and self-efficacy.

Together, involvement and identification create a feeling of empowerment as the individual is actively involved in working on personally meaningful activities, or making progress towards personally significant goals. Therefore, they are no longer simply learning; rather they are engaged in a meaningful, self-relevant activity. The involvement that is experienced while engaging in the activity creates positive affect and promotes reengagement with the activity; in other words, the activity has intrinsic value and is intrinsically motivating (Csikszentmihalyi, 1990; Deci & Ryan, 1985; Eccles, 2005). In addition, there is extrinsic value in engaging in an activity that enables the student to make progress toward desired goals, such as when learning geometry is perceived as a helping the student become a successful engineer. Therefore, the motivation is external to the activity and the value is extrinsic to the task itself. Empowerment therefore seems to have both intrinsic and extrinsic components, which may yield unique motivational benefits. Individuals may be motivated by factors within the task itself (involvement) as well as by factors externally linked to the task (identification).

These processes of involvement and identification may be particularly empowering when students are able to create the connections on their own rather than being told. Discovering how math applies to life may be especially effective in getting students involved in their learning, and even fostering a sense of identification with the activity. This process may be less likely to occur if the usefulness of the activity is emphasized by a teacher or parent. As mentioned earlier, experimental manipulations that emphasized the future relevance of a math activity undermined the interest of students with low ability perceptions (Godes et al., 2007) and interest in math (Durik & Harackiewicz, 2007). Thus, the process of internalizing the relevance of the activity may be crucial for the beneficial effects of utility value to occur (through involvement and identification). These processes are examined in several ways in my dissertation.

First, in Part 1 of my dissertation, I focus on perceptions of utility value as an initial mediator of manipulated utility value effects. It is crucial to establish that the manipulation of utility value impacts perceptions of utility value, and that these perceptions subsequently impact interest and performance. Therefore, we establish this component of the process model first. Second, in Part 2 of my dissertation, perceptions of involvement and identification are differentiated from perceptions of utility value. This allows us to assess the unique contribution of each measure in the mediation of utility value effects. These processes will be examined by manipulating utility value and measuring the effects on the process variables, and their unique effects on the outcomes. This extends prior research in two ways: 1) by manipulating utility value we will be adding an experimental test of utility value, allowing causal inference, and 2) by measuring the hypothesized process variables we will increase our understanding of why utility value has its effects.

Current Research, Part 1: Experimental Studies with College Students

The results of prior correlational research suggest that utility value predicts both performance and interest. Part 1 of my dissertation research tests – through an experimental manipulation – whether utility value can promote interest and performance. In a series of two randomized experiments, one in the laboratory and one in a college classroom, utility value was manipulated through a writing intervention in which participants explained how the activity was relevant to their lives.

Study 1 – The Laboratory

The purpose of Study 1 was to investigate the effects of an experimental intervention on a mental math learning activity. College undergraduates were randomly assigned to the relevance writing condition (i.e., utility value) or the control writing condition, and their perceived utility value and interest in the math task was assessed at the end of the session. We hypothesized that participants in the relevance writing condition would be more interested in the math activity at the end of the session than those in the control condition. We also expected that these effects would be moderated by participants' perceived math competence, such that those with low perceived competence would benefit more from the intervention than those with high perceived competence. In addition, we hypothesized that both of these effects would be mediated by participants' utility perceptions.

Method

Participants

One hundred and seven undergraduate students (50 males, 57 females) were recruited from the introductory psychology subject pool at University of Wisconsin, Madison to participate in the study. Participants were 92% Caucasian, 3% Asian, 1% African American, and 4% Hispanic. Participants were run individually and received extra credit upon completion of the 60 minute session.

Design and Procedure

The study used a two-cell (writing condition: relevance vs. control) between-subjects design. The dependent variables were participants' interest at the end of the learning session, inclination to use the new technique in the future, and performance on a math test.

Participants were run through the session individually. After completing a consent form and a measure of initial interest in math, an audio recording guided the participants through a colorful instructional notebook that taught them a four-step method for solving two-digit multiplication problems in their head (adopted from Flansburg & Hay, 1994; see Barron & Harackiewicz, 2001, for a more detailed description). After the learning session, participants were given three minutes to practice the technique on a practice problem set. Following this practice period they completed a measure of perceived competence. Next, the experimenter handed the participant a folded sheet of paper (to ensure that the experimenter was blind to condition) that contained instructions for writing either a relevance or control essay. All participants were given 10 minutes to type the essay on a laptop computer. Participants in the relevance writing condition were told:

> Type a short essay (1 – 3 paragraphs in length) briefly describing the potential relevance of this technique to your own life, or to the lives of college students in general. Of course, you'll probably need more practice with the technique to really appreciate its personal relevance, but for purposes of this writing exercise, please

> focus on how this technique could be useful to you or to other college students, and give examples.

Participants in the control writing condition were instructed to write about two pictures that were hanging on the wall of the experimental room. The pictures were of either math-related scenes (e.g., a man examining charts and figures) or art-related scenes (e.g., covers from the *New Yorker* magazine) that contained enough objects and detail to describe in a 10 minute essay. Participants in the control writing condition were told:

> Type a short essay (2 paragraphs) describing the objects that you see in both pictures; simply describe in detail the objects that you see. First, in one paragraph, simply describe in detail the objects that you see in the picture on the left. Second, in one paragraph, simply describe in detail the objects that you see in the picture on the right.

After writing the essay, all participants were given six minutes to work on the official problem set while using the new technique. Next, they were shown how many problems they solved correctly on the official problem set. Participants then completed measures of utility value and final interest. Lastly, we assessed their inclination to use the technique in the future.

Measures

Initial Interest. Participants' initial interest in math was measured using a 4-item scale ("I find math enjoyable," "Math just doesn't appeal to me," "I enjoy working on math problems," "I like learning new math concepts"; $\alpha = .93$). Participants responded to all self-report items in this study on a 7-point Likert-type scale from 1 (*strongly disagree*) to 7 (*strongly agree*).

Initial Performance. The total number of problems solved correctly on the practice multiplication problem set constituted a measure of participants' initial performance.

Perceived Competence. Participants' perceived competence at using the technique on the practice problem set was measured with a 2-item scale ("I felt that I was using the technique correctly," "I felt that I was doing poorly (reversed)"; $\alpha = .74$).

Utility Value. The perceived usefulness of the math technique was assessed in two ways. First, each of the essays was coded by two research assistants who were blind to the experimental conditions and hypotheses of the study. The essays were coded for the presence of utility value for the math technique (i.e., everyday, future/long-term, classes, general/other), and the number of examples of utility value in the essay. The coders read each of the 107 essays independently and assigned a rating. Differences were resolved through discussion (84% initial agreement). The number of types and examples of utility value were each standardized, and then the scales were averaged to create a composite index of the degree of Observed Utility Value that participants mentioned in their essays ($M = 0.00$, $SD = 0.98$; $\alpha = .98$). Second, participants' perceptions of the technique's utility value after using it on the problem sets were measured using a 3-item scale (e.g., "This technique could be useful in everyday life," "I don't think this technique would be useful to me in the future (reversed), " "To be honest, I don't think this technique is useful (reversed)"; Perceived Utility Value, $\alpha = .84$).

Final Interest. Participants' interest in the technique and enjoyment of using it on the problem sets was measured using a 5-item scale ("The left-to-right technique is interesting," "Using this multiplication technique is fun," "It was a waste of time to learn this technique (reversed)," "I enjoyed using the left-to-right technique," "The learning program was enjoyable"; $\alpha = .89$).

Inclination. Participants' behavioral inclination to re-engage with the new technique beyond the learning session was assessed by asking, "Do you think you will use the technique you learned today on your own in the future;" "Yes" or "No." Participant responses were coded as '0' for "no" and '1' for "yes".

Final Performance. The total number of problems solve correctly on the official multiplication problem set was used as a measure of participants' final performance.

Results

Manipulation Check

In order to test whether or not the relevance condition caused participants to write about more personal relevance in their essays than those in the control condition, we conducted an independent samples t-test using the coders' ratings of Observed Utility Value as the dependent variable. The t-test indicated that participants in the relevance conditions mentioned significantly more utility value in their essays (M = 1.74, SD = 0.61) than those in the control conditions (M = 0.00, SD = 0.00), $t(105) = 19.91$, $p < .01$. In order to ensure that participants in the relevance conditions did not write more than those in the control conditions, we also examined the number of sentences that participants wrote in their essays. The t-test indicated that participants in the relevance group (M = 9.52, SD = 2.87) actually wrote fewer sentences than those in the control condition (M = 12.87, SD = 3.50), $t(105) = -5.43$, $p < .01$. Thus, we could be assured that our manipulation was effective because it caused participants to mention more utility value in their essays and was not an artifact of the total amount that they wrote.

Overview of Analyses

The data were analyzed using hierarchical multiple regression in three stages. In stage 1 we examined direct effects of our writing manipulation on the outcomes of Final Interest, Inclination, and Final Performance. In stage 2 we examined the direct effects of the writing manipulation on Observed and Perceived Utility Value. In stage 3 we tested whether these utility measures mediated the direct effects of the writing intervention on the outcomes.

Prior to conducting analyses we standardized all continuous variables. Interaction terms were created by multiplying the variables together. Preliminary analyses revealed that the main effect of gender, as well as the two- and three-way interactions between gender, Perceived Competence, and writing condition were not significant predictors of any outcome, so they were trimmed from the final model. The final regression model consisted of four terms: Initial Interest, Perceived Competence, writing condition dummy code (0 = control and 1 = relevance), and the two-way interaction between Perceived Competence and writing condition. The interaction was included to test whether our intervention functioned differently for individuals with low and high levels of perceived competence. Significant interactions were examined by computing predicted values based on estimates for one standard deviation below and above the mean on perceived competence (Aiken & West, 1991). Descriptive statistics and zero-order correlations for all measures are presented in Table 1.

Direct Effects on Final Interest, Inclination, and Performance

Final Interest. The final model accounted for a significant portion of the variance in Final Interest, $F(4, 102) = 6.86$, $p < .001$, $R^2 = .21$. There was a significant main effect of writing condition, $t(102) = 2.69$, $p < .01$, ($\beta = .24$), indicating that participants in the relevance condition ($\hat{Y} = 5.15$) became more interested in the technique than participants in the control condition ($\hat{Y}$

= 4.64). This main effect was qualified by a significant interaction between writing condition and Perceived Competence, $t(102) = -2.34$, $p < .05$, ($\beta = -.21$). As shown in Figure 3A, participants low in perceived competence found the technique to be more interesting in the relevance condition ($\hat{Y} = 5.22$) than in the control condition ($\hat{Y} = 4.27$). Individuals with high perceived competence found the new technique to be equally interesting in both the relevance ($\hat{Y} = 5.07$) and control conditions ($\hat{Y} = 5.01$). In addition, the significant effect of Initial Interest, $t(102) = 2.30$, $p < .05$, ($\beta = .21$), indicated that participants who entered the study with higher levels of initial interest in math found the technique more interesting than those with lower levels of initial interest.

Inclination. Logistic regression was used to analyze the results from the dichotomous (0 = no, 1 = yes) measure of inclination. Regressing inclination on the final model revealed that the four variables in the model accounted for approximately 30% of the explained variation (Nagelkerke $R^2 = .30$). There was a significant main effect of writing condition, Wald $\chi^2(1, N = 107) = 7.95$, $p < .01$, odds ratio (OR) = 10.27, indicating that participants in the relevance condition were more inclined to use the technique in the future than those in the control condition. There was also a significant main effect of Perceived Competence, Wald $\chi^2(1, N = 107) = 5.82$, $p < .05$, odds ratio (OR) = 0.15, indicating that participants with low levels of perceived competence were more inclined to use the technique in the future than those with high perceived competence. As shown in Figure 3B, these main effects were qualified by a significant interaction between Perceived Competence and writing condition, Wald $\chi^2(1, N = 107) = 8.86$, $p < .01$, odds ratio (OR) = 11.76, indicating that participants with low perceptions of competence were more inclined to use the technique in the relevance condition than in the control condition.

Participants with high perceived competence reported similar levels of inclination in the two conditions.

Final Performance. The final model for performance also included participants' score on the practice problem set to control for initial ability in mental math, and the model accounted for a significant portion of variance in Final Performance, $F(5, 101) = 45.57$, $p < .001$, $R^2 = .69$. The only significant effect was that of Initial Performance, $t(101) = 12.78$, $p < .001$, ($\beta = .82$), indicating that participants with higher initial ability in mental math performed better than those with lower initial ability. The direct effects of the relevance intervention on the Study 1 measures are presented in Figure 4.

Direct Effects on Utility Value Process Variables

Observed Utility Value. The final model accounted for a significant portion of the variance in Observed Utility Value, $F(4, 102) = 103.92$, $p < .01$, $R^2 = .80$. A main effect of writing condition emerged, $t(102) = 19.91$, $p < .01$, ($\beta = .87$), indicating that participants in the relevance condition mentioned more utility value ($\hat{Y} = 0.77$) than participants in the control condition ($\hat{Y} = -2.73$). This main effect was qualified by a significant two-way interaction between writing condition and Perceived Competence, $t(102) = -2.41$, $p = .02$, ($\beta = -.11$). An inspection of the predicted values indicated that the relevance condition caused participants with low perceptions of competence to mention slightly more utility value ($\hat{Y} = 0.97$) than those with high perceptions of competence ($\hat{Y} = 0.58$). In contrast, participants in the control condition mentioned low levels of utility value in their essays whether they were low ($\hat{Y} = -1.00$) or high in perceived competence ($\hat{Y} = -0.97$).

Perceived Utility Value. The final model accounted for a significant portion of the variance in Perceived Utility Value, $F(4, 102) = 4.12$, $p < .01$, $R^2 = .14$. As predicted, a main effect of writing condition emerged, $t(102) = 2.03$, $p < .05$, ($\beta = .19$), indicating that participants in the relevance condition ($\hat{Y} = 5.34$) found the technique to be more useful at the end of the session than participants in the control condition ($\hat{Y} = 4.92$). This main effect was qualified by an interaction between writing condition and Perceived Competence, $t(102) = -3.06$, $p < .01$, ($\beta = -.29$). As shown in Figure 3C, participants with low perceptions of competence found the technique more useful in the relevance condition ($\hat{Y} = 5.61$) than in the control condition ($\hat{Y} = 4.54$). In contrast, participants with high perceptions of competence found the technique equally useful in the relevance ($\hat{Y} = 5.29$) and control conditions ($\hat{Y} = 5.06$). Because participants completed the self-report measure of utility value near the end of the session, and the essay was written during the middle of the session, we also included Observed Utility Value into the model as a predictor of Perceived Utility Value. Adding Observed Utility Value to the model revealed a significant effect, $t(102) = 2.81$, $p < .01$, ($\beta = .58$), indicating that participants who mentioned more utility value in their essays subsequently perceived more utility value in the task than those who mentioned less utility value in their essays. The direct effects of the relevance intervention on the utility value process measures are presented in Figure 4.

Mediation Analyses

We examined whether Perceived and Observed Utility Value mediated the effect of the relevance manipulation on Final Interest and Inclination. To carry out these analyses, we added Perceived and Observed Utility Value to our final model, resulting in a 6-term model. We followed procedures outlined by Kenny, Kashy, & Bolger (1998) to test the mediated/indirect effects. In this case, the direct effect of the writing manipulation, and the interaction between the writing manipulation and perceptions of competence, was multiplied by the effects of each mediator on the outcome of interest (i.e., the alpha -beta term, or the indirect effect). The new product term is divided by its standard error to produce a significance test for mediation. This technique has been shown to be robust to Type I errors (MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002). The mediation path model is presented in Figure 5.

Mediated and indirect effects of Utility Value on Final Interest. Adding Perceived and Observed Utility Value to the original model on Final Interest accounted for significantly more variance than the final model (R^2–change = .38, $p < .001$). Perceived Utility Value was a significant predictor of Final Interest, $t(100) = 2.05$, $p = .04$, ($\beta = .67$), indicating that participants who perceived more utility value in the math technique ended up finding it more interesting than those who perceived less utility value in the technique. Neither the main effect of the writing manipulation, nor its interaction with perceptions of competence, were significant. The formal test of mediation revealed that Perceived Utility Value mediated the effects on Final Interest for both the relevance manipulation, $z = 2.58$ ($p < .01$), and its interaction with perceived competence, $z = 2.23$ ($p = .03$.).

Mediated and indirect effects of Utility Value on Inclination. Adding Perceived and Observed Utility Value to the original logistic regression model on Inclination accounted for more variance than the final model (Nagelkerke R^2-change = .16). There was a significant main effect of Perceived Utility Value, Wald $\chi^2(1, N = 107) = 8.83$, $p < .01$, odds ratio (OR) = 142.87, indicating that participants who perceived more utility value in the math technique were more inclined to use the technique in the future than those who perceived less utility value in the technique. Neither the main effect of the writing manipulation, nor its interaction with perceptions of competence, were significant. The formal test of mediation revealed that Perceived Utility Value mediated the effects on Final Interest for both the relevance manipulation, $z = 1.96$ ($p = .05$), and its interaction with Perceived Competence, $z = 2.83$ ($p < .01$).

Summary of Treatment Effects

The direct and mediated effects of the relevance intervention are summarized in Figures 4 and 5, respectively. As presented in Figure 4, the treatment had significant direct effects on all four of the motivational variables in Study 1 (i.e., Final Interest, Inclination, Perceived Utility Value, and Observed Utility Value). In addition, these effects were moderated for each variable by a significant interaction between the relevance intervention and Perceived Competence (see Figure 4). For individuals with low perceived competence, the effects of the intervention were substantial (β's from .45 to .98). In contrast, for individuals with high perceived competence, the effects of the intervention were nearly zero (β's from-.10 to -03), except for the effect on Observed Relevance ($\beta = .76$).

Discussion – Study 1

The results of Study 1 demonstrated that an experimental intervention designed to manipulate perceptions of the usefulness of a math task was successful in doing so. This relevance intervention was also successful in increasing participants' interest in the math task, as well as their inclination to use it in the future. These direct effects were particularly strong for participants with low perceptions of competence. In addition, the mediational analyses supported our hypothesized model of utility value effects. The direct effects of the manipulation on Final

Interest and Inclination were mediated by the degree of utility value participants perceived in the math technique and the degree of utility value mentioned in participants' essays. These results demonstrate the effectiveness of the relevance intervention in increasing utility value and interest, particularly for participants with low perceptions of competence. The next step is to extend this work into an actual classroom.

Study 2 – The College Psychology Classroom

Study 2 was a randomized experiment conducted in an undergraduate psychology class. Students were randomly assigned to one of four conditions at mid-semester: two were relevance writing conditions and two were control conditions. The two main questions addressed in Study 2 were: 1) Does the relevance intervention increase perceptions of utility value within the context of a college class?, and 2) Does the intervention subsequently affect student interest? We hypothesized that students in the relevance writing groups would be more interested in the course at the end of the semester than those in the control conditions. We again expected that these effects would be more pronounced for students with lower perceptions of ability. However, in Study 2 we substituted students' actual performance for their perceived performance. Thus, we expected that the effects of the intervention would be greater for students who were not performing well in the course. In addition, we hypothesized that the effects of the intervention would be mediated through students' perceptions of utility value and the degree of utility value observed in their essays.

Because our prior research has indicated the important role that achievement goals play in the development of interest and performance in classrooms (Harackiewicz et al., in press; Harackiewicz et al., 2002), but also serving as a foundation for the perception of value

(Hulleman, Durik et al., 2007), we included an assessment of achievement goals in both of the classroom studies in this dissertation (Studies 2 and 3). Achievement goals have been defined as the purposes or reasons for task engagement in achievement settings (Ames, 1984; Dweck, 1986; Nicholls, 1984). Recent conceptualizations have divided goals into a 2 (mastery/performance) x 2 (approach/avoidance) framework (Elliot & McGregor, 2001; Pintrich, 2000). Mastery-approach goals focus on developing knowledge and learning new skills, whereas mastery avoidance goals focus on avoiding and not learning or mastering a task. Performance-approach goals focus on doing well compared to other people, whereas performance-avoidance goals focus on not doing worse than others.

Research has demonstrated that mastery-approach goals positively predict a variety of motivational variables including classroom interest (Ames & Archer, 1988; Harackiewicz, Barron, Pintrich, Elliot, & Thrash, 2002; Lee, Sheldon, & Turban, 2003), deep processing, effort and persistence (Elliot, McGregor, & Gable, 1999; Harackiewicz et al., 2000; Midgley, Kaplan, & Middleton, 2001; Wolters, Yu, & Pintrich, 1996), but not performance (Harackiewicz et al., 2002; but see Grant & Dweck, 2003). Performance-approach goals are positively linked to academic performance (Harackiewicz, Barron, Pintrich et al., 2002; but see Grant & Dweck, 2003), but not interest. Performance-avoidance goals have been negatively associated with interest and performance (Midgley et al., 2001; Harackiewicz et al., 2000). Mastery-avoidance goals have been examined less frequently, with the few studies which have included them finding a mixed pattern of results (see Elliot, 2005 for a review).

Method

Overview

This study took place during the course of a 16-week semester at a large, Midwestern university and consisted of three waves of data collection during the semester. Students' initial interest in the course topic was assessed on the second day of the semester (Wave 1); their initial perceptions of course value (intrinsic and utility) and achievement goals (mastery- and performance-approach) were measured two weeks into the semester, but before the first exam (Wave 2); and final measures of utility value and interest in the course were collected during the 13^{th} week of the semester (Wave 3). We also obtained students' final course grades from department records. The writing intervention occurred during the second half of the semester (weeks 9 -12).

Participants and Setting

Participants were recruited from an Introductory Psychology class that consisted of approximately 350 students. Only students who were taking the course for graded credit and who agreed to complete our surveys were included in the sample (N = 318; 91% of the students in the course). No other demographic information was obtained. Classes were primarily in lecture format. Students' grades were determined by their performance on four multiple-choice exams given at four-week intervals throughout the semester. Final grades were assigned based upon a normative curve recommended by the Psychology Department. Students completed the surveys during class time and received extra credit for completing all three surveys.

Writing Intervention

At the mid-point of the semester, students were randomly assigned to one of four writing conditions – two of which were intended to help students see the relevance of the course material to life (Letter, Media), and two of which were intended to serve as control groups (Outline, PsychINFO). In all four of the groups, students were asked to select a topic that was currently being covered in class (e.g., the effect of sleep loss on cognitive functioning). Following the selection of a topic, students in the Letter condition (N = 78) were asked to think of a person who the topic might apply to (e.g., friend, relative, significant other) and to write a 1 -2 page letter describing the issue and the relevance of the material to this other person. Students in the Media condition (N = 82) were asked to find a media report (e.g., magazine, newspaper, internet, etc.) that pertained to the issue they selected and write a 1 – 2 page paper that discussed the relevance of the media report to information they were learning in class. Students in the Outline condition (N = 78) were asked to create a 1 -2 page outline or summary of the topic they selected. Students in the PsycINFO condition (N = 80) were asked to search the PsychINFO database for two abstracts relating to the topic they selected, summarize them, and discuss how the abstracts expanded upon the material they were learning in class. These writing interventions were part of the course syllabus and were completed for 5 points each (10 points total) of course credit. Each student was asked to complete their assigned essay twice during the second-half of the semester – once in the 10th week and again in the 12th week of the semester. All students (N = 318) completed at least one of the essays, and 92% (N = 295) completed both of the required essays. The instructor, who was blind to students' condition, graded each essay on a scale from 0 to 5 (Essay 1: M = 4.16, SD = 0.86; Essay 2: M = 4.24, SD = 4.24).

Measures

Initial interest. Students' initial interest in the course topic and anticipated reactions to learning the course material were assessed with five items (e.g., "I think I will like learning about psychology in this course") and were based on prior research (Harackiewicz, Barron, Tauer, &

Elliot, 2002; Harackiewicz et al., 2007; Hulleman, Durik et al., 2007). The complete scale items are presented in Appendix B ($\alpha = .91$; Initial Interest). Participants responded to all self-report items in this study on a 7-point Likert-type scale from 1 (*strongly disagree*) to 7 (*strongly agree*).

Achievement goals. Students' mastery-approach (e.g., "My goal in this class is to learn as much as I can") and performance-approach goals for the course (e.g., "My goal in this class is to get a better grade than most of the other students") were each assessed with three items and based on the 2 x 2 model of achievement goals proposed by Elliot (1999; Elliot & McGregor, 2001). The scale items for the mastery and performance-approach goal items are presented in Appendix B (Mastery $\alpha = .83$, Performance $\alpha = .82$).

Initial task values. Students' initial perceptions of utility value were assessed with a three-item scale, e.g., "I think what we are studying in Introductory Psychology is useful for me to know" ($\alpha = .78$; Initial Utility Value). Students' perceptions of intrinsic value were assessed with a three-item scale, e.g., "I enjoy coming to lecture" ($\alpha = .88$; Initial Intrinsic Value). The complete scale items are presented in Appendix B.

Initial performance. Students initial performance in the course was calculated by summing their scores on their first two exams (Initial Exams).

Utility value. We used one observed measure from the student essays and one self-reported measure in Study 2. Similar to Study 1, each of the student essays was coded by two research assistants who were blind to the experimental conditions and hypotheses of the study. The essays were coded on two dimensions. The degree of utility value that students' wrote about was coded on a scale from 0 to 3, with more points indicating an increased number of applications and/or a better description of how the material was useful or applicable to life

(Observed Utility Value). To rate the extent to which participants personalized what they were writing about, the coders counted the number of personal pronouns used in the essay, e.g., I, me, mine, us, our, ours (Pronouns). The coders read each of the 624 essays independently and assigned a rating. Cronbach's alphas were acceptable for ratings of utility value (0.72 for Essay 1 and 0.82 for Essay 2) and number of pronouns (0.99 for Essay 1 and 0.95 for Essay 2). Differences were resolved through discussion. The ratings for Essay 1 and Essay 2 were averaged to create an overall index of Observed Utility Value ($M = 0.64$, $SD = 0.76$) and number of personal pronouns ($M = 9.91$, $SD = 13.23$). Because these two measures were highly correlated ($r = .76$, $p < .001$), the values were standardized and averaged to form a composite rating of Observed Relevance ($M = 0.01$, $SD = 0.95$; $\alpha = .86$).

In addition to the observed measure, self-reports of students' perceived utility value at the end of the semester used the same items as the initial measure of utility value (three items, $\alpha = .88$, Perceived Utility Value). The items are presented in Appendix B. Descriptive statistics for each of the experimental conditions are presented in Table 2.

Final Interest. Students' final interest in the course was assessed with a five-item scale, e.g., "I think the field of psychology is very interesting" ($\alpha = .84$; Final Interest).

Inclination. Students' behavioral inclination to major in psychology was measured with one item, "I am interested in majoring in psychology."

Final Grade. Students' final course grades were obtained from departmental records. Each student could receive one of seven possible grades, based on the university's 4-point scale. The average grade in this study was 2.75 ($SD = .90$). Grades were distributed as follows: A = 17.3%, AB = 13.1%, B = 18.5%, BC = 17.3%, C = 25.3%, D = 5.7%, and F = 3.0%.

Results

Preliminary Analyses

Attrition and missing data. The initial sample of 318 students included individuals who did not complete all three waves of the survey: 292 students completed Wave 1 (Initial Interest), 272 completed Wave 2 (Initial Intrinsic Value, Initial Utility Value, Mastery and Performance goals), and 272 completed Wave 3 (Perceived Utility Value, Final Interest, Inclination). The attrition was primarily due to students missing class on the day the surveys were administered: Eight students did not complete any of the three waves of data collection, 20 missed two waves of data collection, and 81 students (26%) missed at least one wave of data collection. In sum, of the original sample of 318 students, 237 students (74%) had complete data on all 3 waves. We conducted an analysis that compared the total sample (N = 318) to those individuals who missed at least one wave of data collection because they failed to attend class on the day of data collection (N = 81). Comparisons were made on all the major variables in the study: Initial Interest, Utility Value, Intrinsic Value; Mastery- and Performance-approach goals; Final Interest and Grade.

Independent samples t-tests revealed three significant differences. Effect sizes (Cohen's *d*) were computed for these differences, revealing small to medium effects. The total sample endorsed higher levels of Performance-approach goals, $t(316) = 2.80$, $p < .01$, $d = .32$, and attained higher initial exam scores, $t(316) = 2.57$, $p < .01$, $d = .29$, and Final Grades, $t(316) = 3.86$, $p < .01$, $d = .43$, than the students who missed at least one wave of data collection.

In the results section we report multiple regression analyses using students with data on all three waves (N = 237). We also conducted Structural Equation Modeling analyses using Full

Information Maximum Likelihood (FIML) in Lisrel 8.72 (Jöreskog & Sörbom, 1998) to simultaneously test the complete path model. FIML uses the EM algorithm to produce starting values when estimating the complete covariance matrix among all the variables (Enders, 2006). This approach utilizes the information from all students who completed at least one wave of the surveys (N = 318). A comparison of the results indicated a consistent pattern of effects across analyses types and sample sizes. Thus, in this paper we report the multiple regression analyses. The SEM results can be obtained upon request.

Randomization. Student participants in our study were randomly assigned to one of four experimental conditions at the mid-point of the semester. To verify that the randomization was successful, we conducted one-way ANOVAs on all the variables assessed prior to the randomization (i.e., Initial Interest, Initial Utility Value, Mastery-approach goals, Performance-approach goals, and Initial Exams). Table 2 presents the mean differences and F-tests between the four experimental conditions. If the randomization worked successfully, then there should be no differences between the experimental groups on any of the initial variables. As can be seen in Table 2, none of the one-way ANOVAs were significant (all F's < 1.58, all p's $> .34$). Thus, we can be reasonably confident that the experimental groups are relatively equivalent on the initial measured variables in our study.

Manipulation checks. In order to test whether or not the relevance conditions (Media, Letter) caused participants to find more personal relevance in the material than those in the control conditions (PsycINFO, Outline), we conducted tests using the coders' ratings of Observed Relevance as the dependent variable. First, we conducted a one-way ANOVA to see if there were mean differences among the groups on Observed Relevance. Second, we conducted follow-up tests to determine which conditions differed on Observed Relevance. The overall F-test was significant, $F(3, 225) = 142.91$, $p < .001$. The follow-up t-tests indicated that students in the two relevance conditions mentioned more utility value and used more pronouns in their essays ($M = 0.50$) than those in the control conditions ($M = -0.44$), $t(235) = 8.79$, $p < .01$ ($d = 1.30$). In addition, within the relevance conditions, students in the Letter group mentioned more utility value and used more pronouns ($M = 1.41$) than those in the Media group ($M = -0.32$), $t(112) = 13.73$, $p < .01$. The difference between the Outline and PsycINFO groups was not significant ($p > .50$).

Descriptive and correlational analyses. Means and standard deviations of all the major variables in this study are presented in Table 2. The correlation matrix and scale reliabilities are presented in Table 3.

Overview of Analyses

We used hierarchical multiple regression to analyze these data in two stages. First, we investigated the effects of the relevance manipulation on the outcomes, controlling for our initial measures of interest, task values, and achievement goals. Second, we tested the mediational effects of Observed Relevance and Perceived Utility Value on Final Interest, Inclination, and course grades.

Direct Effects Analyses

Direct effects models. The first set of analyses tested the direct effects of the experimental conditions on Final Interest, Inclination, and Grades. The four experimental conditions were represented by three orthogonal contrast codes. The Value contrast compared the two relevance conditions (Letter and Media = +1) to the two control conditions (Outline and PsychINFO = -1).

The Letter contrast compared the two relevance conditions: Letter = +1, Media = -1). The Outline contrast compared the two control conditions: Outline = +1, PsycINFO = -1). We also included the initial measures (Initial Interest, Initial Utility and Intrinsic Values, Mastery- and Performance-approach goals), Sex (males = -1, females = 1), Initial Exams, and all their two-and three-way interaction terms. As in Study 1, prior to the regression analyses all continuous variables were standardized and interaction terms were created by multiplying variables together. Only significant interactions were retained in the models.

Final Interest. The overall model was significant, $F(10, 236) = 24.04$, $p < .01$ ($R^2 = .52$). There was a significant main effect of the Value contrast, $t(236) = 3.20$, $p < .01$, ($\beta = .15$), indicating that participants in the relevance conditions (Letter, Media) reported more interest in psychology at the end of the course ($\hat{Y} = 4.84$) than participants in the control conditions (Outline, PsycINFO; $\hat{Y} = 4.45$). This direct effect was moderated by a significant interaction with Initial Exams, $t(236) = -2.94$, $p < .01$, ($\beta = -.14$). This interaction is presented in Figure 6A. The predicted values indicated that students with lower exam scores in the relevance conditions reported more interest in the course ($\hat{Y} = 4.82$) than those in the control conditions ($\hat{Y} = 4.44$). Students with higher exam scores reported equivalent levels of interest in the course in the relevance ($\hat{Y} = 4.87$) and control conditions ($\hat{Y} = 4.86$). In addition, there were direct effects of Initial Exams, $t(236) = 3.28$, $p < .01$, ($\beta = .16$), Mastery-approach goals, $t(236) = 4.11$, $p < .01$, ($\beta = .23$), Initial Intrinsic Value, $t(236) = 3.09$, $p < .01$, ($\beta = .19$), and Initial Interest, $t(236) = 5.75$, $p < .01$, ($\beta = .35$), indicating that students with higher levels of these variables at the beginning of the semester were more interested in the course at the end of the semester than those students with lower levels.

Inclination. The overall model was significant, $F(10, 236) = 4.41$, $p < .01$ ($R^2 = .17$). Neither the direct effect of the intervention, $t(236) = 0.13$, $p = .90$, ($\beta = .01$), nor its interaction with Initial Exams, $t(236) = -1.19$, $p = .18$, ($\beta = -.08$), were significant. However, the direct effect of Initial Interest was significant, $t(236) = 3.18$, $p < .01$, ($\beta = .27$), indicating that students who began the semester with higher levels of interest were more inclined to major in psychology at the end of the semester.

Final grade. Because students' final grade included their mid-semester exam grades, Initial Exams were excluded from the model on final grades. There were no significant direct effects on Final Grade in the direct effects model. The direct effects path model is presented in Figure 7.

Mediation Analyses

Overview of mediation/indirect effects models. The second set of analyses tested the role of both Perceived Utility Value and Observed Relevance as mediators or indirect paths between the experimental intervention and Final Interest, Inclination and Grades. First, we tested whether the writing conditions were significantly related to the measures of utility value by using the direct effects regression model to predict Perceived Utility Value and Observed Relevance. Second, we tested whether Perceived Utility Value and Observed Relevance were related to the outcomes, while controlling for the original predictors, by including these hypothesized mediators in the direct effects model. Thus, unless otherwise noted, the mediation model contained 12 terms: 10 terms from the direct effects model with the addition of the two utility value terms. The significance of the mediated and indirect effects were tested using the z-test procedure (Kenny, Kashy, & Bolger, 1998).

Direct effects on Observed Relevance. The overall model was significant, $F(11, 236) = 42.99$, $p < .01$ ($R^2 = .66$). There was a significant direct effect of the Value contrast, $t(236) = 13.17$, $p < .01$, ($\beta = .52$), indicating that participants in the relevance conditions ($\hat{Y} = 0.54$) used more pronouns and mentioned more utility value in their essays than participants in the control conditions ($\hat{Y} = -.44$). There was also a significant direct effect of the Letter contrast, $t(236) = 16.02$, $p < .01$, ($\beta = .64$), indicating that participants in the letter condition ($\hat{Y} = 0.91$) used more pronouns and mentioned more utility value in their essays than those in the Media condition ($\hat{Y} = -0.82$). No other effects were significant.

Direct effects on Perceived Utility Value. The overall model was significant, $F(10, 236) = 22.14$, $p < .01$ ($R^2 = .50$). Although the direct effect of the Value contrast was not significant, $t(236) = 1.58$, $p = .12$, ($\beta = .08$), the interaction between the Value contrast and Initial Exams was significant, $t(236) = -2.46$, $p = .02$, ($\beta = -.12$). This interaction is presented in Figure 6B. The predicted values indicated that students with lower exam scores in the relevance conditions ($\hat{Y} = 4.47$) perceived more utility value in the course than those in the control conditions ($\hat{Y} = 4.01$). Students with higher scores perceived equivalent levels of utility value in the course in the relevance ($\hat{Y} = 4.74$) and control conditions ($\hat{Y} = 4.85$). The significant direct effects of Initial Exams, $t(236) = 4.79$, $p < .01$, ($\beta = .23$), Mastery-approach goals, $t(236) = 3.75$, $p < .01$, ($\beta = .21$), Initial Utility Value, $t(236) = 4.21$, $p < .01$, ($\beta = .28$), and Initial Interest, $t(236) = 3.79$, $p < .01$, ($\beta = .24$), indicated that students who reported higher levels of those variables subsequently perceived more utility value in the course than those with lower levels. No other effects were significant. The direct effects path model for Perceived and Observed Utility Value is presented in Figure 7.

Mediated/ indirect effects on Final Interest and Grades. Final Interest was regressed on the mediation model and it accounted for significantly more variance than the direct effects model (R^2-change = .18, $p < .01$). The significant direct effects of Perceived Utility Value, $t(236) = 11.08$, $p < .01$, ($\beta = .53$), and Observed Relevance, $t(236) = 1.92$, $p = .056$, ($\beta = .12$), indicated that students who perceived higher levels of utility value in the course, and who mentioned more utility value in their essays, reported more interest in psychology at the end of the semester. Neither the direct effect of the Value contrast, nor its interaction with Initial Exams, were significant in the mediation model. The formal test of mediation revealed that the direct effect of the Value contrast on Final Interest was partially mediated by Observed Relevance, $z = 1.90$ ($p = .057$), and that the interaction between the Value contrast and Initial Exams was mediated by Perceived Utility Value, $z = 2.40$ ($p = .02$) Although the direct effects of Mastery-approach goals ($\beta = .10$, $p = .03$), Initial Intrinsic Value ($\beta = .13$, $p < .01$), and Initial Interest ($\beta = .21$, $p < .01$) all remained significant, the test of mediation revealed that Perceived Utility Value partially mediated the effects on Final Interest for Mastery goals, $z = 3.55$ ($p < .01$), and Initial Interest, $z = 3.59$ ($p < .01$).

Inclination was regressed on the mediation model and accounted for significantly more variance than the direct effects model, (R^2-change = .08, $p < .01$). The direct effect of Perceived Utility Value, $t(236) = 4.78$, $p < .01$, ($\beta = .39$), indicated that students who perceived higher levels of utility value in the course reported more interest in majoring in psychology at the end of the semester. Initial Interest remained a significant predictor of Inclination, $t(236) = 2.04$, $p = .04$, ($\beta = .17$). The formal test of mediation revealed that Perceived Utility Value provided a significant indirect effect on Inclination for the interaction between the Value contrast and Initial Exams, $z = 2.19$ ($p = .03$).

Final Grade was regressed on the mediation model and accounted for significantly more variance than the direct effects model, (R^2-change = .08, $p < .01$). There was a significant direct effect of Perceived Utility Value, $t(236) = 4.25$, $p < .01$, ($\beta = .36$), indicating that students who perceived higher levels of utility value in psychology received higher grades than students who perceived lower levels of utility value. No other effects were significant. The overall mediation path model is presented in Figure 8.

Summary of Treatment Effects.

The direct and mediated effects of the relevance intervention are summarized in Figures 7 and 8, respectively. As presented in Figure 7, the treatment had significant direct effects on Observed Relevance and Final Interest. In addition, there were significant interactions between the relevance intervention and Perceived Competence on Observed Relevance, Perceived Utility Value, and Final Interest (see Figure 7). For individuals with low perceived competence, the effects of the intervention were small to moderate (β's = .20 and .29). In contrast, for individuals with high perceived competence, the effects of the intervention were nearly zero (β's = -.04 and .01).

Study 2 Discussion

The results of Study 2 demonstrated that the relevance intervention successfully increased students' interest in the course, particularly for students with lower exam scores. The intervention was particularly effective for students with low perceived competence in Study 1, and for students with low grades in Study 2, as predicted. The degree to which students mentioned utility value in their essays, along with their perceptions of utility value, mediated the direct effects of the intervention on interest, and inclination to major in psychology. In other words, the effectiveness of the intervention in raising interest corresponded to the degree that participants wrote about and perceived utility value in the course. In addition, students' perceptions of utility value predicted their final course grades and thus provided an indirect pathway for the intervention to impact student performance.

Thus, Studies 1 and 2 demonstrate that an intervention designed to increase perceptions of utility value produced an increase in interest for an experimental laboratory task (Study 1) and a course topic (Study 2). Study 2 also replicated prior research that has demonstrated an association between perceived utility value and performance (Hulleman, Durik, et al., 2007; Simons et al., 2003, 2004). However, one drawback to these studies is that, like much of the previous classroom research that has examined the relationship between utility value and learning outcomes, our findings are based on studies of college undergraduates. If theories of motivation are to apply to the context of education more broadly, then the investigation of utility value needs to include younger students. High school classrooms tend to be very different places than college classrooms, and these differences have implications for the generalizability of results as well as for theoretical models. For example, there are more restrictions on attendance and course choices in high school, with most students being required to take a specific sequence of courses in each subject area. In contrast, there are fewer restrictions in college, with college students able to choose different elective courses and majors. Thus, in the next study we examined whether the intervention was effective with high school students who were taking required freshman biology courses. We also examined more carefully the processes of interest development as they unfolded over the course of a high school semester.

Interest Development in the Classroom

One compelling issue, particularly for educators, is to understand how interest develops when both individual and situational interest are low. In high school, low levels of individual interest in academic topics may be particularly pronounced, because academic interest is at its lowest point in the early high school grades (Jacobs et al., 2002; Wigfield & Tonks, 2002). This may be due not only to personal factors, such as low levels of pre-existing interest, but also to low levels of situational interest induced by instructional practices. Several researchers have noted that ninth-and tenth-grade classrooms tend to de-emphasize high level cognitive processing in favor of surface-level activities (Walberg, House, & Steele, 1973; Wigfield, Eccles, & Pintrich, 1996). Research on instructional practices and student engagement has demonstrated that classroom exercises which require higher-order thinking skills tend to be more engaging for students (Stipek, 2002). Thus, the interaction between the high school student – with low levels of individual interest – and the high school classroom – with low levels of intellectual stimulation – is not conducive to the discovery and deepening of interest. This context provides an opportunity to investigate the development of interest from the bottom up; that is, to examine the development and deepening of interest from initially low levels of individual and situational interest.

Current Research, Part 2: A Randomized Trial with High School Students

Part 2 of my dissertation research extends previous research and Part 1 of my dissertation by considering whether the relevance manipulation studied with college students might have the same effects with high school students. Part 2 also extends prior research by examining involvement and identification as mediators of the relevance intervention effects as outlined in Figure 2. I hypothesize that students in the relevance condition will report more interest in the course material than those in the control condition. I expect that this effect will be particularly strong for students with low perceptions of ability. In terms of mediating processes, I hypothesize that the relevance intervention will increase students' utility perceptions (both observed and perceived), involvement, and identification with the course material. In turn, these processes should directly predict interest and performance.

Study 3 – The High School Science Classroom

Method

Overview

This study took place during the course of a semester at three Midwestern high schools and consisted of three waves of data collection during the semester. Students' initial attitudes towards science and the course (i.e., interest in science, task values, achievement goals) were assessed during the second week of the semester (Wave 1); their utility perceptions, and degree of involvement and identification with the course were measured at the end of the first quarter (Wave 2); and final measures of interest and future course and career plans involving science were collected during the final week of the semester (Wave 3). Students' second quarter course grades were obtained from the teachers. The writing intervention occurred at multiple points during the semester, beginning at approximately the third week (i.e., after Wave 1).

Participants

Participants were 428 high school students from 21 science classrooms taught by 9 teachers across three Madison high schools. Ten of the classes were required freshman biology; nine classes were part of an integrated science program, primarily for ninth-graders, that covered biology, chemistry, physics, and geology; and two classes were elective physical science courses. All students in each class were eligible for participation in this study. Informed consent was obtained from all participants and their parents at the beginning of the semester. Because the treatment intervention was a component of the course curriculum established by each teacher, students and parents were only able to opt out of the survey portion of the research ($N = 51$). This resulted in a sample ($N = 377$) that enrolled in the study at Time 1 by completing the first survey. This was 88% of the total number of students enrolled in the 21 classrooms at the beginning of the Fall semester. Due to student absences, students leaving the district, and schedule changes, the overall sample was reduced to 338 students who completed our Time 2 surveys, and 320 students who completed our Time 3 surveys. Thus, the final sample for which we have complete data consisted of 296 students. In this paper we present data for as much of the original sample when possible ($N = 377$). For example, an analysis involving only Time 1 measures would include the original 377 students, whereas an analysis involving Time 2 measures would include a maximum of 338 students.

Writing Intervention

During the second week of the semester, students were randomly assigned to one of two writing conditions – in the relevance condition, we asked students to apply what they were learning in class to real life, and in the control condition we asked students to write a summary of what they were learning. In both conditions, students were asked to select a topic that was currently being covered in class (e.g., photosynthesis). Following the selection of a topic, students in the relevance condition (N = 191) were asked to write a one-paragraph essay that applied the topic to their life or to the life of someone they knew. Students in the control condition (N = 186) were asked to write a one-paragraph summary of the topic they selected. The writing intervention was part of the course syllabus and was completed for course credit. In order to keep teachers blind to each student's experimental condition, the instructions for the writing assignment were placed inside an essay booklet that students received during the second week of the semester. Students placed their name on the outside of the book and wrote their essays inside each book. Teachers were instructed to have students complete an essay as part of their review activities one to two days prior to each test. The teachers were asked not to read or grade the essays. Rather, after each test the researcher collected the booklets, read the essays, and assigned them a score from 0 to 3 points. The instructor then used this score as a basis to award course credit. The researcher returned the booklet for the student to use prior to the next test. The number of essays that students wrote during the semester varied in each classroom according to how many tests were offered by the teacher. Overall, students completed an average of 3.95 essays (*SD* = 1.72, *Median* = 4, *Mode* = 5).

Measures

Time 1: Initial measures. Students' perceptions of their ability were assessed with a two-item scale, e.g., "Considering the difficulty of this course and my skills, I think I will do well in this class," and "I expect to do well in this class" (α = .73; Perceived Ability). Students' Initial Interest in science was assessed with a three-item scale, e.g., "I think what we are learning in this class is interesting" (α = .86; Initial Interest). Students' perceptions of initial utility value at the beginning of the semester was assessed with a three-item scale, e.g., “I can see how what I learn from science applies to life” ($\alpha = .82$; Initial Utility Value). Students’ Mastery-approach goals were assessed with a two-item scale, e.g., “My goal in this class is to learn as much as I can” ($\alpha = .86$). Students’ mastery-avoidance goals were assessed with a two-item scale, e.g., “I just want to avoid learning less than I have in other courses” ($\alpha = .46$). Students’ Performance-approach goals were assessed with a two-item scale, e.g., “I want to do better than other students in this class” ($\alpha = .86$). Students’ Performance-avoidance goals were assessed with a two-item scale, e.g., “My goal in this class is to avoid doing poorly compared to others” ($\alpha = .65$). Participants responded to all self-report items in this study on a 5-point Likert-type scale from 1 (*strongly disagree*) to 7 (*strongly agree*).

Time 2: Utility value. We used one observed measure from the student essays and three self-reported measures as process variables in Study 3. The observed measure was similar to those used in Studies 1 and 2. Each of the student essays was coded by two research assistants who were blind to the experimental conditions and hypotheses of the study. The essays were coded on four dimensions. The degree of utility value that students’ mentioned in their essays was coded on a scale from 0 to 3, with higher scores indicating an increased number of applications and/or a better description of how the material was useful or applicable to life (Observed Utility Value). To rate the extent to which participants personalized what they were writing about, the coders counted the number of personal pronouns used in the essay, e.g., I, me, mine, us, our, ours (Pronouns). The amount of text that each student generated for each essay was quantified as the total number of sentences (Sentences). The quality of the writing was assessed on a 0 to 3 point scale, with more points indicating a higher quality essay (Essay

Quality). The coders read each of the 1,820 essays independently and assigned a rating. Cronbach's alphas were excellent for ratings of Observed Utility Value (α = .92), number of pronouns (α = .97), number of sentences (α = .98), and Essay Quality (α = .93). Differences were resolved through discussion (average agreement = 85%). As in Studies 2 and 3, the ratings for Observed Utility Value and Pronouns were standardized and averaged to create an overall index of Observed Relevance (M = 0.01, SD = 0.88; α = .68). Descriptive statistics for each of the experimental conditions are presented in Table 4. Students' perceived utility value at mid-semester used the same items as the initial measure of utility value (three items, α = .82, Perceived Utility Value).

In addition to these measures of utility value, two process measures were collected at mid-semester. Students' perceptions of feeling involved and absorbed in the course (i.e., Involvement) was measured with a four-item scale, "In this class, I feel like I get involved with doing the assignments," "In this class, we learn the material through 'hands on' activities, such as labs," and "I play an active role in my learning in this class," "This class allows us to discover things on our own instead of just being told" (α = .73). Students' perceptions of identification and importance of the material (i.e., Identification) was measured with a two-item scale, "Science class is important because it helps me become the person I want to be," and "Science class is important because it will help me reach my future goals" (α = .86).

Time 3: Outcome measures. Students' final interest in the course was measured with the same three-item scale used in the initial measure of interest (α = .84; Final Interest). Students' interest in future science courses and careers was measured with a four-item scale, e.g., "My experience in this class makes me want to take more science courses," "I want to have a job that involves science some day" ($\alpha = .84$; Future Plans). Students' grades for the second quarter were obtained from the teachers. Each student could receive one of five possible grades (i.e., A – F). The average grade in this study was 2.12 (*SD* = 1.45). Grades were distributed as follows: A = 22.4%, B = 23.1%, C = 19.9%, D = 13.4%, and F = 21.3%.

Results

Preliminary Analyses

Attrition and missing data: Self-report measures. The initial sample of 428 students included individuals who did not complete all three waves of the survey: 377 students completed Wave 1 (Perceived Ability, Initial Interest, achievement goals, Initial Utility Value), 338 completed Wave 2 (Perceived Utility Value, Involvement, Identification), and 320 completed Wave 3 (Final Interest, Future Plans). The attrition was primarily due to students missing class on the day the surveys were administered: 19 students did not complete any of the three waves of data collection, 97 missed two waves of data collection, and 132 students (31%) missed at least one wave of data collection. In sum, of the original sample of 428 students, 296 students (69%) had complete data on all 3 waves. We conducted an analysis that compared the total sample (N = 428) to those individuals who missed at least one wave of data collection because they failed to attend class on the day of data collection (N = 131). Comparisons were made on all of the self-reported variables in the study: Initial Interest and Utility Value, achievement goals, Perceived Utility Value, Involvement, Identification, Final Interest, Future Plans, and Grades.

Independent samples t-tests revealed that the total sample endorsed higher levels of Involvement, $t(426) = 2.31$, $p = .02$, $d = .27$, than the students who missed at least one wave of data collection. No other differences were significant (all t's < 1.83, all p's < .07).

Attrition and missing data: Grades. Due to an administrative error, we were only able to obtain students' second quarter grades for a sub-sample of students (N = 200). Of the students with second quarter grades, 56 of them missed at least one wave of data collection. Thus, we compared this group to the total sample of students with grades. The independent samples t-test was not significant ($t < 1.76$, $p > .08$).

Treatment compliance and dosage. Nearly all of the students who were randomly assigned to an experimental condition actually received the treatment (425 of 428 students). Thus, the impact of treatment compliance ("no-shows"; Bloom, 1984) on the treatment effect is negligible. However, the strength of the manipulation, or in this case the number of treatment "doses" that each participant received, was not equal. As indicated in Table 5, there was a substantial range in the number of essays written by each participant. Although there are a number of methods which have been proposed to deal with this dosage effect (Bloom, 2005), these approaches were not utilized in this study as treatment effects were obtained without this additional control. However, future analyses could incorporate an instrumental variable approach (Bloom, 1984), for example, to further probe the intervention's effects.

Randomization. Student participants in our study were randomly assigned to one of two experimental conditions at the beginning of the semester. To verify that the randomization was successful, we conducted independent samples t-tests on all the initial variables in our study (i.e., Perceived Ability, Initial Interest, Initial Utility Value, and Achievement Goals). Table 4 presents the mean differences and t-tests between the experimental conditions. If the randomization worked successfully, then there should be no differences between the experimental groups on any of our initial measures. As can be seen in Table 4, Initial Interest in science was higher in the control condition (*M* = 4.19) than in the relevance condition (*M* = 3.99), t(374) = 1.97, p = .049, d = .20. None of the other differences were significant (all *t*'s < 1.68, all *p*'s > .10).

Manipulation checks. In order to test whether or not the relevance condition caused participants to mention more personal relevance in the material than those in the control condition, we conducted an independent samples t-test using the coders' ratings of Observed Relevance as the dependent variable. The t-test indicated that participants in the relevance condition (*M* = 0.47, *SD* = 0.48) mentioned significantly more utility value and used more personal pronouns than those in the control condition (*M* = -0.45, *SD* = 0.48), $t(422) = 13.56$, $p < .01$, $d = 1.29$. In addition, we tested whether the experimental conditions differed on Sentences or Essay Quality. For Sentences, the t-test indicated that participants in the relevance condition (*M* = 3.66, *SD* = 1.78) used fewer sentences than those in the control condition (*M* = 4.14, *SD* = 2.18), $t(422) = 2.51$, $p = .01$, $d = 0.24$. For Essay Quality, the t-test indicated that essays in the relevance condition (*M* = 1.80, *SD* = 0.36) did not differ in quality from those in the control condition (*M* = 1.81, *SD* = 0.38), $t(422) = 0.19$, $p = .85$, $d = 0.02$. Overall, these manipulation checks indicated that the relevance condition induced participants to mention more utility value and use more personal pronouns in their essays, and that this increase was not due to an increase in the amount that students wrote or in the quality of their essays.

Correlational analyses. The correlation matrix for the variables in this study is presented in Table 6.

Factor analyses. To test our hypothesis that identification and involvement are separate processes distinct from utility value, an exploratory factor analysis (EFA) was conducted in

SPSS 14.0 using the nine items from Time 2. As can be seen in Table 7, each item loaded onto its theorized factor (all loadings $\geq$ .341), and item cross-loadings were negligible (all loadings $\leq$ .242). The average loadings for each factor were .561 for Involvement, .863 for Identification, and .640 for Perceived Utility Value. The Involvement and Identification factors were moderately correlated, as expected ($r = 0.39$), and both were correlated with Perceived Utility Value ($r = 0.61$ and $r = 0.64$, respectively).

Overview of Analyses

Hierarchical Linear Modeling (HLM). Given the nested structure of the data (students within classrooms within teachers within schools), hierarchical linear modeling (HLM) is an appropriate method to analyze the data (Raudenbush & Bryk, 2002). HLM estimates a statistical model that takes into account the interdependencies in the data – between students in the same classroom, between classrooms taught by the same teacher, and between teachers within the same school – by estimating within and between component variance. In a typical ordinary least squares (OLS) regression, a student-level model is estimated with only one error term. In Equation 1, student interest ($\hat{Y}_{ijk}$) is predicted as a function of the grand mean of interest (β_0) and the treatment effect (β_1), plus an error term (ε_i).

(1) $\hat{Y}_{ijk} = \beta_0 + \beta_1\text{Treatment} + \varepsilon_i$

However, this model does not account for correlated errors within classrooms, teachers, and schools. By not accounting for these dependencies in the data, the standard errors of OLS regression may be too small, and therefore tests of significance will be biased towards finding an effect (i.e., a Type I error). Instead, HLM allows student-level relationships (i.e., the regression slope between the treatment and interest) to vary randomly across classrooms, teachers, and schools. Accounting for the between classroom variance is accomplished by adding two equations.

Equation 2 predicts the variability in the mean level of student interest (β_0) across classrooms. Equation 3 predicts the variability in treatment effects (β_1) across classrooms. In essence, the error term in each equation captures the variability across classrooms in both the mean of interest (intercept random error = μ_1) and in the treatment effect (treatment effect random error = μ_2). Our model now has two levels: a student level (Level 1) and a classroom level (Level 2):

(2) $\beta_0 = \gamma_1 + \mu_1$

(3) $\beta_1 = \gamma_2 + \mu_2$

Next, we can extend this logic to account for teacher effects by adding two more equations. Our model now includes a third level (teacher). Equation 4 predicts the variability in the mean level of interest (γ_1) as a function of teacher. Equation 5 predicts the variability in the treatment effect (γ_2) as a function of teacher. The error term in each equation captures the variability across teachers in both the mean of interest (intercept random error = r_1) and in the treatment effect (treatment effect random error = r_2). Finally, we can account for the effects of schools by adding a contrast code for the schools (D1) to the teacher level equations.

(4) $\gamma_1 = \pi_{1.0} + \pi_{1.1}\mathrm{D1} + r_1$

(5) $\gamma_2 = \pi_{2.0} + \pi_{2.1}\mathrm{D1} + r_2$

Thus, by accounting for the hierarchical structure of the data, not only will we have accurate estimates of the standard errors, but we will also know whether the experimental intervention varies across classrooms, teachers, and schools.

Analytic Strategy. We used hierarchical linear modeling in HLM 6.04 (Raudenbush, Bryk, Cheong, Congdon, &du Toit, 2004) to analyze these data in two stages. First, we investigated the effects of the relevance manipulation and initial measures on the Time 3 outcomes. Second, we tested the mediational effects of utility perceptions (Perceived and Observed) on the Time 3 outcomes. Third, we added the mediational effects of Involvement and Identification to the mediational model on Time 3 outcomes.

For the following analyses, all continuous main effect terms were centered, and multiplicative two- and three-way interaction terms were created with these variables (Aiken & West, 1991; Raudenbush & Bryk, 2002). Interactions that were significant on any measure were retained in all models, but non-significant interactions were trimmed from models. To interpret significant interaction effects from these analyses, we computed predicted values ($\hat{Y}$s) for representative high and low groups (one standard deviation above and below the mean) from the HLM equations using the unstandardized gamma coefficients. In addition, we utilized multiple regression to compute standardized coefficients for the path models. In these regression models we included interaction terms to account for the fixed effects of classrooms, teachers, and schools (Raudenbush & Bryk, 2002).

Unconditional Model

The first step in an HLM analysis is to estimate the percentage of variance in outcomes at each of the three levels in our model (student, classroom, and teacher). The bottom of Tables 8 and 9 present the percentage of variability at each level for the outcomes and mediators, respectively. Across the seven measures, the majority of variance was at the student level (M = 96%) as compared to the classroom (M = 2%) and teacher levels (2%). The variable with the largest amount of classroom level variance was Grades (6%), whereas Observed Relevance had the largest amount of teacher level variance (8%). Although this variance components analysis demonstrated that the nesting of students in higher level groupings will most likely not have a large effect on our analyses, we modeled the nesting structure so that accurate standard errors would be obtained.

Direct Effects Analyses

Direct effects models. In the first set of HLM analyses, we tested the effects of the experimental manipulation, Perceived Ability, Initial Interest, Initial Utility Value, and Achievement Goals on the Time 3 outcomes, controlling for the clustering of students within classrooms, teachers, and schools using HLM 6.04 (Raudenbush et al., 2002). At the student level, we included a dummy code for the two experimental conditions (0 = control, 1 = relevance), and terms for Initial Interest, Initial Utility Value, Perceived Ability, Mastery-approach goals, Mastery-avoidance goals, Performance-approach goals, and Performance-avoidance goals. In our initial analyses, we included all two-and three-way interaction terms. Only significant interactions were retained in the final models (i.e., Perceived Ability and the relevance manipulation, Initial Interest and the relevance manipulation). Equation 6 presents this student-level equation. At the classroom level, we included the random effects on the student-level intercept and on each term that included the experimental intervention (Equation 7). At the teacher level, we included the random effects on the student-level intercept and the experimental intervention. We also included a single contrast code for schools (-1, 0, 1) as a fixed effect in the teacher-level model (Equation 8). The equations for the direct effects analyses are presented below:

Student-level:

(6) $\hat{Y}_{ijk} = \beta_0 + \beta_1$Treatment + β_2Perceived Ability + β_3Initial Interest + β_4Initial Utility Value + β_5Mastery-approach + β_6Mastery-avoidance + β_7Performance-approach + β_8Performance-avoidance + β_9Treatment*Perceived Ability + β_{10}Treatment*Initial Interest + ε_i

Classroom-level:

(7) $\beta_0 = \gamma_0 + \gamma_1 + \gamma_2 + \gamma_3 + \gamma_4 + \gamma_5 + \gamma_6 + \gamma_7 + \gamma_8 + \gamma_9 + \mu_0 + \mu_1 + \mu_9 + \mu_{10}$

Teacher-level:

(8) $\gamma_0 = \pi_0 + \pi_{0.1}\mathrm{D1} + \pi_1 + \pi_{1.1}\mathrm{D1} + \pi_2 + \pi_3 + \pi_4 + \pi_5 + \pi_6 + \pi_7 + \pi_8 + \pi_9 + \pi_{10} + r_0 + r_1$

The results of the direct effects HLM analyses on Time 3 Final Interest, Future Plans, and Grades are presented in Table 8.

Final Interest. The model accounted for 43% of the variation in Final Interest. There was a significant direct effect of Initial Interest (β = .45), indicating that students who reported more interest in the course at the beginning of the semester reported more interest at the end of the semester. There was significant variation in the mean level of student interest due to schools (i.e., a school fixed effect on the intercept), indicating that the mean level of student interest varied across the three schools ($\pi_{0.1}$ = -.38, $p < .05$). In terms of random effects, there was also significant variation in the interaction between the relevance intervention and Perceived Ability due to classrooms (i.e., a classroom-level random effect), indicating that the two-way interaction between the intervention and Perceived Ability varied across classrooms (μ_9 = 0.14, $p < .05$).

Future Plans. The model accounted for 34% of the variation in Future Plans. There were significant direct effects of Initial Interest (β = .36), Performance-approach goals (β = .22), and Performance-avoidance goals (β = -.20), indicating that students with higher levels of Initial

Interest and Performance-approach goals, and with lower levels of Performance-avoidance goals, reported more plans to be involved with science in the future. In terms of random effects, there was a significant classroom level random effect on the interaction with Perceived Ability ($\mu_9 = 0.19$, $p < .05$), and Initial Interest ($\mu_{10} = 0.02$, $p < .05$), indicating that these two-way interaction coefficients varied across classrooms.

Grades. The model accounted for 20% of the variation in second quarter grades. Although there were no significant student-level direct effects, there was significant classroom variation in the effect of the relevance manipulation ($\mu_1 = 0.25$, $p < .05$), and of its interaction with Perceived Ability ($\mu_9 = 0.42$, $p < .01$). These effects indicated that the effect of the relevance intervention was not identical across all 21 classrooms. The direct effects path model for Study 3 is presented in Figure 9.

Mediated/Indirect Effects

Overview of mediated/indirect effects models. The second set of analyses tested the role of Perceived Utility Value, Observed Relevance, Involvement, and Identification as mediated/indirect paths between the experimental conditions and the Time 3 outcomes. First, we tested whether the relevance manipulation and initial measures were significantly related to the mediators by using the direct effects HLM model (see Equations 6 – 8) to predict the two measures of utility perceptions, Involvement, and Identification. Table 9 presents the results of the HLM analysis on the mediators.

Second, as a parallel analysis to Studies 1 and 2, we tested whether utility perceptions were related to the outcomes, while controlling for the original predictors, by including Perceived Utility Value and Observed Relevance in the student level of the HLM direct effects model (Equation 6). This mediational/indirect effects analysis parallels the mediational/indirect effects analyses in Studies 1 and 2 and is presented in Figure 10 and Table 8.

Third, we added Involvement and Identification into the mediational HLM model described above as mediated/indirect paths between the experimental conditions and the Time 3 outcomes. This analysis allowed us to test the unique contributions of Involvement and Identification, over and above utility perceptions, in the mediated/indirect paths from the intervention to the outcomes. This path model is presented in Figure 11.

Direct effects on Observed Relevance. The model accounted for 45% of the variance in Observed Relevance. There was a significant direct effect of the relevance manipulation (β = .60), indicating that students in the relevance condition mentioned more utility value and used more personal pronouns than those in the control condition. There was a significant direct effect of mastery-avoidance goals (β = .10), indicating that students who adopted higher levels of mastery-avoidance goals mentioned more utility value in their essays than those who adopted lower levels. There was also a significant teacher random effect ($r_1 = .05$, $p < .05$), and a school fixed effect ($\pi_{0.1} = -.41$, $p < .05$), on the relevance intervention, indicating that the relevance intervention effects varied as a function of teacher and school.

Direct effects on Perceived Utility Value. The model accounted for 52% of the variance in Observed Relevance. Although the direct effect of the relevance intervention was not significant, there was a significant interaction with Perceived Ability (β = - .12). As presented in Figure 12A, students with low Perceived Ability perceived more utility value in the relevance condition ($\hat{Y} = 2.40$) than those in the control condition ($\hat{Y} = 1.97$). Students with high Perceived Ability perceived an equal amount of utility value in the course whether they were in the relevance ($\hat{Y}$ = 2.13) or the control condition ($\hat{Y}$ = 2.20). There was also a significant interaction between the relevance manipulation and Initial Interest, indicating that students who were less interested perceived more utility value in the control condition ($\hat{Y}$ = 3.75) than those in the relevance condition ($\hat{Y}$ = 3.40). In contrast, students who were more interested perceived more utility value in the relevance condition ($\hat{Y}$ = 3.84) than those in the control condition ($\hat{Y}$ = 3.70).

There were also significant direct effects of Initial Utility Value (β = .44) and Mastery-approach goals (β = .22), indicating that students who initially perceived more utility value in the course and who adopted higher levels of Mastery-approach goals subsequently perceived more utility value in the course at mid-semester than students who adopted lower levels. No other effects were significant.

Direct effects on Involvement. The model accounted for 30% of the variation in Involvement. There was a significant direct effect of Perceived Ability (β = .27), indicating that students who thought they would do well in the course became more actively involved in the course than those students who thought they would do poorly. This effect was qualified by the significant interaction with the treatment conditions (β = -.21). As presented in Figure 12B, students with low Perceived Ability became more involved in the relevance condition ($\hat{Y}$ = 3.37) than those in the control condition ($\hat{Y}$ = 2.88). Students with high Perceived Ability were equally involved whether they were in the relevance ($\hat{Y}$ = 3.52) or the control condition ($\hat{Y}$ = 3.36). There was also a significant direct effect of Mastery-approach goals (β = .22), indicating that students who adopted higher levels of Mastery-approach goals subsequently felt more involved in their learning at mid-semester than those who adopted lower levels.

In terms of random effects, there was a significant classroom level random effect on the interaction between the intervention and Perceived Ability ($\mu_9 = 0.12$, $p < .01$), indicating that this two-way interaction on Involvement varied across classrooms. There was also significant variation in the mean level of Involvement due to schools, indicating that the mean level of Involvement varied across the three schools ($\pi_{0.1} = -.30$, $p < .05$).

Direct effects on Identification. The model accounted for 40% of the variance in Identification. There was significant interaction between Perceived Ability and the treatment conditions ($\beta = -.17$). As presented in Figure 12C, students with low Perceived Ability in the relevance conditions identified more with the course material ($\hat{Y} = 2.33$) than those in the control conditions ($\hat{Y} = 1.79$). Students with high Perceived Ability reported equal levels of identification in both the relevance ($\hat{Y} = 2.11$) control condition ($\hat{Y} = 2.19$). In addition, there were significant direct effects of Performance-approach goals ($\beta = .19$), Performance-avoidance goals ($\beta = -.15$), and Initial Utility Value ($\beta = .22$). Students who adopted higher levels of Performance-approach goals, lower levels of Performance-avoidance goals, or who perceived more utility value in the material at the beginning of the semester were more likely to identify with the course material at mid-semester.

In terms of random effects, there was a significant classroom level random effect on the interaction with Perceived Ability ($\mu_9 = 0.03$, $p < .05$), indicating that this two-way interaction varied across classrooms. There was also significant variation in the mean level of Identification due to schools, indicating that the mean level of Identification varied across the three schools ($\pi_{0.1} = -.37$, $p < .05$).

Mediated/Indirect effects of utility perceptions on Final Interest. The significant direct effects of Perceived Utility Value (β = .35), indicated that students who perceived more utility value in the material at mid-semester reported more interest at the end of the semester. The test of the indirect effect of the relevance intervention indicated a significant indirect path through Perceived Utility Value, z = 1.97 (p = .05). In addition, the direct effect of Initial Interest (β = .38) remained significant. In terms of random effects, the significant variation in the interaction between the relevance intervention and Perceived Ability also remained significant in the indirect effects model. However, the effect of schools on the mean level of student interest was no longer significant ($\pi_{0.0}$ = -.21, p = .07), indicating that the utility perceptions partially accounted for the between-school differences in Final Interest.

Mediated/Indirect effects of Utility Perceptions on Future Plans. The significant direct effect of Perceived Utility Value (β = .30) indicated that students who perceived more utility value in the course at mid-semester reported more plans to be involved with science in the future. The test of the indirect effect of the relevance intervention indicated a significant indirect path through Perceived Utility Value, z = 2.26 (p = .02). The significant classroom level variation in the interaction between the relevance intervention and Perceived Ability remained significant in the indirect effects model. However, the effect of schools on the mean level of students' future plans was no longer significant ($\pi_{0.0}$ = -0.24, p > .10), indicating that utility perceptions partially accounted for the between-school differences in student interest.

Mediated/Indirect effects of utility perceptions on Grade. The significant direct effect of Observed Relevance (β = .37) indicated that students who mentioned more utility value and pronouns in their essays subsequently earned higher second quarter grades. The test of the indirect effect of the experimental manipulation on second quarter grades indicated a significant path through Observed Relevance, $z = 2.49$ ($p = .01$). No other effects were significant. The utility perceptions path model is presented in Figure 10.

Mediated/indirect effects of Involvement and Identification on Final Interest. Adding Involvement and Identification to the mediational model on Final Interest revealed significant effects of Involvement ($\beta = .11$), Identification ($\beta = .15$), and Perceived Utility Value ($\beta = .21$). The test of the indirect effects from the intervention to Final Interest revealed a marginally significant path through Involvement, $z = 1.79$ ($p = .07$), and a significant path through Perceived Utility Value, $z = 1.97$ ($p = .05$). In addition, the direct effect of Initial Interest remained significant ($\beta = .38$).

Mediated/indirect effects of Involvement and Identification on Future Plans. Adding Involvement and Identification to the mediational model on Future Plans revealed a significant effect of Identification ($\beta = .40$). The test of the indirect effect from the intervention to Future Plans revealed a marginally significant path for Identification, $z = 1.68$ ($p = .09$). In addition, the direct effect of Initial Interest remained significant ($\beta = .25$).

Mediated/indirect effects of Involvement and Identification on Final Grades. Adding Involvement and Identification to the mediational model on Grades revealed significant effects of Involvement ($\beta = .26$), and Observed Relevance ($\beta = .22$). The test of the indirect effects from the intervention to Grades revealed significant paths for Involvement, $z = 2.00$ ($p < .05$) and Observed Relevance, $z = 2.49$ ($p = .01$). The complete indirect effects model is presented in Figure 11.

Summary of Treatment Effects

The direct and mediated effects of the relevance intervention are summarized in Figures 9 - 11. Although the relevance intervention did not have direct effects on any of the Time 3 final outcome variables, it was predictive of the process measures for students with low, but not high, perceptions of ability (see Figure 9). For individuals with low perceptions of ability, the effects of the intervention were small to moderate (β's = .18 to .20). In contrast, for individuals with high perceptions of ability, the effects of the intervention were nearly zero (β's = -.04 to -.09). The random effects analyses revealed significant variation in treatment effects due to classrooms for Final Interest, Future Plans, and Grades.

Exploratory Process Analyses

Because Perceived Utility Value, Involvement, and Identification were assessed at the same time point, we did not test whether Perceived Utility Value led to subsequent Involvement and Identification. However, there was a sub-sample of the data that included an additional measure of Involvement and Identification at a separate time point (about half-way between the Time 2 and 3 measures). This sub-sample was considerably smaller than that used for the analyses on Final Interest and Future Plans (N = 207 vs. N = 296) and Grade (N = 144 vs. N = 200). As a result, this time point of data collection was not included in the original data analysis. As an exploratory analysis, this sub-sample was used to test a path model with the additional measures (Time 2.5) in two stages: 1) predicting Involvement and Identification at Time 2.5 with the intervention, Time 1 initial measures, and Time 2 Perceived Utility Value; and 2) predicting Time 3 outcomes with the intervention, Time 1 initial measures, Time 2 Perceived Utility Value, and Time 2.5 Involvement and Identification. This allowed us to test if Perceived Utility Value was predictive of Involvement and Identification, measured at a later time point, and if these process measures were uniquely related to the outcomes.

The results of this analysis are presented in Figure 13 and are fairly similar to those of the overall process analyses presented in Figure 11. The relevance intervention lead to higher levels of Observed Relevance (β = .60) and Perceived Utility Value (β =.20) at mid-semester for students with low ability perceptions. In turn, Perceived Utility Value predicted an increase in both Involvement (β =.40) and Identification (β =.25) several weeks later. Involvement was then significantly related to both Grades (β = .17) and Final Interest (β =.17), whereas Identification was significantly related to both Final Interest (β = .20) and Future Plans (β =.51). Perceived Utility Value was also significantly related to Final Interest (β =.22).

Discussion – Study 3

The results of this study again demonstrated that the relevance intervention successfully increased students' interest in the course, particularly for those with lower perceptions of ability. This time, in contrast to Studies 1 and 2, there was an absence of direct effects of the intervention on the outcomes. Instead, the intervention directly affected the process variables, which then predicted interest and performance. Specifically, the utility intervention increased students' perceptions of how useful the course material was to them (both observed and perceived utility value), how involved they became in their learning (involvement), and how much they identified with the course material (identification). Their involvement and the degree to which they connected the material to their lives in the essays both directly predicted second quarter grades. In contrast, students' level of identification, perceptions of utility value, and involvement predicted their interest in the material at the end of the semester. Identification was the sole predictor of students' future educational and career plans involving science.

The differentiation of utility value processes provided a replication and extension of the first two studies. Studies 1 and 2 demonstrated that the relevance intervention promoted interest as a result of increasing the amount of utility value that students perceived in the task. Study 3 replicated this finding and extended it to include measures of involvement and identification, and examined their unique contributions to interest development and performance. It is interesting to note that involvement, and the degree of personal application in the student writing (observed utility value) were predictive of performance, whereas identification was predictive of future plans. This suggests that an inclination to re-engage with the material in the future was tied to the depth with which the individual connects the activity to who they are. In contrast, performance was tied to the self-reported level of engagement in learning (involvement), as well as to the level of relevance students wrote about in the essays (observed utility value). This may be reflective of an active, engaged learner; that is, a student who is exerting effort towards making personal connections in an essay is more likely to be involved with other classroom activities. This analysis points to the importance of student involvement in the learning process, and highlights the role motivation can play in student achievement (Brophy, 2004; Pintrich, 2003).

In addition, the results of the exploratory mediational analyses suggest that perceptions of utility value are antecedents to subsequent involvement and identification. The time-lagged measures demonstrated the unfolding of relationships over time: the intervention lead to perceptions of utility value at mid-semester, these perceptions then lead to increased involvement and identification nearly 6 weeks later, which subsequently predicted interest and grades at the end of the semester. However, these conclusions should be tempered with the knowledge that a smaller sub-sample of the overall high school sample was used. Further research using other, larger samples will need to replicate these results.

Importantly, this study extended prior research by utilizing a high school sample, and by examining interest development in a context where initial interest was low. Although the strength of the treatment effect was not as strong in the high school classes, the pattern of effects and relationships among variables was similar to those found with college students (see Table 10). In addition, Study 3 examined the effects of the relevance intervention across different classrooms, teachers, and schools. Beyond simply controlling for the nesting of students (and therefore reducing bias in our statistical estimates), the results of the hierarchical analyses revealed that on some measures there was variability in the treatment effect (i.e., there were random effects due to classrooms and teachers). Because we do not have demographic information on students or teachers, we do not have classroom and teacher information with which we could dissect these random effects. For example, the number of honors students in a class might positively impact the level of student engagement and involvement in classroom activities. Conversely, the number of students with behavioral issues in each classroom might have a negative impact on classroom engagement. These variables could be entered into the model at level 2 as predictors of the student level means and slopes (i.e., as classroom level predictors, see Equation 7).

The inclusion of achievement goals as antecedents of utility perceptions revealed different pathways for mastery and performance goals to influence interest and performance. Mastery-approach goals were not directly associated with any of the outcomes in Study 3; however, they were associated with perceptions of utility value and involvement at mid-semester, which in turn predicted interest and performance. This created indirect pathways for mastery-approach goal adoption to influence both interest and performance. In contrast, performance approach goals were directly related to students' future career and education plans in science. This direct effect was mediated by the level of identification with science that students reported at mid-semester. In addition, the relationship with identification provided an indirect pathway through which performance-approach goals were positively related to interest. Similarly, performance-avoidance goals were negatively related to both future plans and identification and therefore undermined students' interest in science. These results support the position that there are multiple pathways to motivation and performance, and that both mastery- and performance-approach goals can have adaptive benefits in the classroom (Hidi & Harackiewicz, 2000; Pintrich, 2003).

General Discussion

The primary purpose of this dissertation was to conduct an experimental investigation of the effects of utility value on interest and performance. Across three randomized experiments – one in the laboratory and two in classrooms – we demonstrated that our relevance intervention, in which we encouraged students to apply the task or course material to their own lives, increased perceptions of utility value. In turn, these utility perceptions predicted increases in task interest and behavioral inclination (Study 1), course interest and inclination to major in psychology (Study 2), and topic interest and inclination (Study 3). These effects were strongest for participants with low competence beliefs (Studies 1 and 3), and low actual competence (Study 2). In addition, we found support for the hypothesized utility value processes outlined in Figure 2. These processes were predictive of interest and classroom performance, and afford insight into the mechanisms of the utility value effects documented here.

Treatment Impact

How effective was the utility value intervention in promoting interest and performance? Table 10 presents the aggregated treatment effects on interest and performance across the three studies, and Table 11 presents the effects of the mediators. Across the three studies, the average direct effect of the intervention on interest (β = .10) and inclination (β = .07) were small. However, in each study the treatment effect varied as a function of the participant's perceived (or actual) ability. For students with low perceptions of ability, the average treatment effect on interest was β = .22 and inclination was β = .17. In contrast, for students with high perceptions of ability, the average treatment effect was negligible for both interest (β = .02) and inclination (β = -.02). Although the intervention did not benefit students with high perceived ability as much as those with low perceived ability, it is important to note that it did not harm their subsequent interest or inclination. A closer inspection of Table 10 reveals a similar pattern on the mediators (e.g., perceived utility value, involvement, etc.).

Importantly, this pattern of effects matches our theoretical conceptualization of the role of utility value in promoting optimal educational outcomes. The perception of value in general – and utility value in particular – is theorized in the expectancy-value framework to be the most proximal predictor of student engagement, interest, and learning. In contrast, contexts that promote the perception of utility value – such as our relevance manipulation – also impact motivation and learning, particularly for individuals with lower ability perceptions. Thus, in our model, the effects of utility value operate in two ways: directly on the outcomes, as seen in Studies 1 and 2, and indirectly through the perception of value, as seen in all three studies. As presented in Table 11, the average effect of perceived utility value across all three studies was β

= .52 on interest, β = .43 on inclination, and β = .22 on performance – considerably higher values than those reported for the main effect of the utility value intervention (β's of .10, .07, and -.01, respectively).

Notably, the effects of the utility value intervention on performance across the three studies were entirely indirect. The average effect size for the main effect of the utility intervention on performance across all three studies was β = -.01, whereas the average effect size for perceptions of utility value was β = .22. This pattern of effects highlights the important role that student attitudes and motivation can play in understanding learning and achievement.

Our data also suggest that as the experimental context moves from the laboratory to the classroom, and from college to high school, the strength of the treatment effect is diluted. In Study 1, there was a direct effect of the manipulation on each motivational variable, as well as an interaction with competence perceptions. Moving to the college classroom in Study 2 resulted in smaller effect sizes, although there were still direct effects on the final outcomes. In Study 3, the direct effects on the outcomes were absent, and the intervention seemed to work primarily through the process variables. Although the process variables were significant predictors of the outcomes, including performance, the downstream effects of the intervention were fully indirect.

This decline in the treatment effect seemed to co-occur with several confounded factors. First, the level of experimental control was reduced when we moved from the well-controlled laboratory to a classroom. In the laboratory, it is less likely that participants will influence each other or discuss the manipulations with other participants. However, in both classroom studies it was impossible to prevent students from talking to each other about what they were writing outside of class. Thus, it is possible that there were contamination effects that may have decreased the differences between the two groups. In addition, in the classroom students were able to select the topic they wrote about, whereas participants were assigned the same topic to write about (mental math) in the laboratory. Because different topics may provide more or less opportunity to make personal connections, some topic choices may have enabled students to write about more utility value in their essays than others, thus increasing the degree of the manipulation that they received. Variability would have been highest in Study 3, because the high school students wrote different numbers of essays about different topics. In other words, the manipulation may have been most uniform in the lab, and least uniform in the high school classroom.

These constraints on the treatment effect are in contrast to conditions that could serve to augment its effectiveness. Beyond variability in treatment dosage, within the classroom context the timing of the implementation may be crucial. Asking students to make connections between a school subject and life may be more powerful when students have developed some background knowledge in the subject, such as when students are asked to reflect on all the material they have learned in a semester review, rather than at the beginning of a unit or early in the learning process. In other words, in order for the process of making applications and discovering value in the material to energize learning, it needs to be woven into the fabric of the course. More generally, motivational interventions are perhaps more likely to succeed when they are integrated into the curriculum and not simply “add-ons” intended to give a short-term boost. As Wlodkowski (1985) argued:

> I am convinced that one of the logical reasons why ineffective and unmotivated learning so frequently occurs is because of the lack of motivation planning on the part of many

> instructors . . . . I contend that for a student to learn and want to learn (motivated learning), motivation planning is necessary. . . . Blaming the learners for being unresponsive to instruction that is actually poorly designed or implemented in terms of its motivational influence is a common reaction among many instructors. (pp. 58-59)

This perspective implies that motivation is not a separate issue from learning but rather an inherent component, and that researchers and educators alike need to consider the timing and context when seeking to increase student motivation.

Utility Value Processes

In the process model depicted in Figure 2, involvement and identification are conceptualized as distinct processes initiated by perceptions of utility value, and hypothesized to influence learning outcomes. In the research presented herein, these processes proved to be crucial in explaining the effects of the intervention on learning outcomes. In fact, in nearly every case the direct effects of the treatment disappeared after the mediators were entered into the path models. In addition, involvement and identification proved to be unique predictors of interest, inclination, and performance above and beyond the effects of perceived utility value. Whereas general perceptions of utility value were predictive of both interest and performance in Study 2, the more fine-grained analysis in Study 3 revealed that the components were differentially related to the outcomes. The components representing active, engaged learning (i.e., self-reports of involvement, actual investment in the relevance intervention) were predictive of learning and performance, whereas identification was uniquely related to future plans. Both involvement and identification were predictive of interest in the course.

Although they are conceptualized as independent constructs, involvement and identification are positively related variables and could produce reciprocal effects. For example, seeing how geometry relates to the future goal of becoming an engineer may energize the student to become more involved in classroom activities. In contrast, becoming involved and engaged in learning may help the student realize that the activity is important for a future career. In addition, it is possible that involvement and identification may unfold over time, such that the perception of utility value instigates the processes of involvement and identification, which in turn impact performance and interest. The exploratory analysis in Study 3 provides preliminary evidence for how utility value effects unfold over time, and initial support for our theoretical conceptualization.

Considering the variability in tasks and contexts in this dissertation research, the consistency in predictive strength of the utility value processes (see Table 11) suggests that our theoretical model is viable. However, this process model should be considered as an initial step in understanding utility value effects on motivation and performance. There are other processes – unmeasured in these studies – that may be influenced by utility value and associated with interest and performance. For example, Simons et al. (2004) surveyed first-year nursing students and found that students who were more identified with their nursing coursework (i.e., the courses were important for both their education and their future careers) were more excited about their courses, studied more regularly, persisted longer when studying, and used deeper processing strategies than students who were less identified with their nursing courses (i.e., the courses were important only for their education). These self-regulatory strategies in turn predicted students' end-of-year exam results. Thus, in addition to involvement and identification, future research could consider self-regulatory strategies as potential mediators of utility value effects in predicting learning outcomes.

Why Utility Value?

A unique aspect of this research, particularly within the expectancy-value tradition (e.g., Eccles et al., 1983), is that we manipulated utility value in addition to measuring it. This combination of experimental and survey approaches allowed us to make firmer conclusions regarding the causal nature of utility value. The differentiation of utility value from other types of task value was done for two reasons. From a theoretical perspective, we wanted to understand how perceived task value contributed to the development of interest over time. In their model of interest development, Hidi and Renninger (2006) proposed that perceived value for a task is a component of both situational and individual interest. In other words, value for a task can be perceived during task engagement or over time as (possibly) a more enduring characteristic of the person. Thus, we made the distinction between situationally experienced task value (i.e., intrinsic and utility) and internally identified task value (i.e., attainment). As mentioned earlier, identification is a process that unfolds over time, whereas task values can be experienced almost immediately upon task engagement. From a practical perspective, we wanted to know how we could address the documented decline in student interest over time (Jacobs et al., 2002; Lepper et al., 2005). The part of the expectancy-value model that seemed to be the most amenable to a classroom intervention was utility value, given its more external nature. In addition, prior correlational research has identified utility value as a potentially important antecedent of both interest and performance.

Internal vs. External

In this research we created a utility value intervention that encouraged individuals to make their own, personal connections with the material. Prior research indicated that emphasizing the utility value of a task undermined interest for those with low perceived competence, but promoted interest for participants with high perceived competence (Godes et al., 2007). However, rather than specifying a particular reason why the activity was relevant for them, participants in our research made connections from their own perspective. By choosing how to connect the task or course material to their lives, participants made the utility value relatively more internal. This manipulation proved to be beneficial for students with low perceptions of competence, and did not harm those with high perceptions of competence. Thus, the present intervention provided a method for allowing students who may be disengaged from learning – due to their low competence beliefs – to connect with the material and potentially re-engage in the learning process. This internalization process may be crucial for understanding why utility value is beneficial for both learning and performance (see also Simons et al., 2004).

This dissertation research also examined whether intrinsic or extrinsic factors were more beneficial for interest and performance. As defined, utility value is a more extrinsic type of task value: The task is important, not for task-intrinsic reasons (i.e., enjoyment), but for task-extrinsic reasons (i.e., as a tool for accomplishing a goal) (Hulleman, Durik et al., 2007). In addition, these task-extrinsic reasons can be person-intrinsic (Simons et al., 2004). That is, the usefulness of a task can be important for the individual's sense of self, such as accomplishing a personally meaningful goal. As a result, we hypothesized that perceiving utility value in a task could lead to processes that are both internally and externally motivating. Involvement – which focuses on the being actively engaged in the learning process – is a more internal type of process. In contrast, identification – which focuses on the importance of the activity for achieving some personally important goal or self-aspect– is relatively more external (although not completely so). Together, these components empower the student (Dewey, 1913; Mitchell, 1993; Papert, 1980) and, as our results suggest, facilitate interest development and performance. Involvement was associated with performance and interest, whereas identification was associated with interest and future plans. These results indicate that a more external type of value can have beneficial effects on outcomes that are typically thought of as being more intrinsic (i.e., interest).

As a second example of how intrinsic and extrinsic factors can work in a complementary fashion to promote motivation and performance, we can examine the role of performance goals in relation to our motivational outcomes. Although performance goals are typically thought of as being extrinsic motivators and are unrelated (performance-approach) or negatively related (performance-avoidance) to interest and intrinsic motivation (Harackiewicz, Barron, Pintrich et al., 2002; Midgley et al., 2001), the results of Study 3 suggest that they can play a role in interest development. Students' performance goals at the beginning of the semester were significantly related to their future plans to be involved in science at the end of the semester, with performance-approach goals being positive predictors and performance-avoidance goals being negative predictors. In addition, both of these direct effects were mediated by students' identification with the course material at mid-semester. Thus, identification provided an indirect pathway for performance-approach goals to promote interest and for performance-avoidance goals to undermine interest. These findings align themselves with the thinking of researchers who propose that there are multiple pathways to optimal motivation and performance, including external reasons such as performance goals (Hidi & Harackiewicz, 2000; Lepper et al., 2005; Pintrich, 2000a).

Implications for Theory

The results of this research have implications for theoretical models of expectancy-value motivation, achievement goals, and interest development. In terms of the expectancy-value model, this research highlights the importance of considering task values as conceptually distinct constructs as originally proposed by Eccles et al. (1983). That is, by focusing on utility value we uncovered relationships with both interest and performance. We obtained initial support for our theoretical model, which suggests that attainment value might best be conceptualized a bit differently from intrinsic and utility value due to the time required for it to develop. In addition, the interaction between our manipulation and students' competence expectancies supports the conceptualization of expectancy-value originally proposed by Atkinson (1957). This model proposes that task values and expectancies are related in multiplicative ways in determining motivation. This is an often overlooked aspect of expectancy-value theory that may prove valuable in understanding student motivation, particularly in response to classroom interventions.

In terms of achievement goals, this model supports the multiple goals/multiple pathways approach to understanding learning and motivation (Pintrich, 2000a). Both mastery- and performance-approach goals had positive, indirect paths to interest and performance, through their relationship with perceived utility value and involvement (mastery), or identification and future plans (performance). However, despite the delineated relationships between task values and goals by both expectancy-value (Eccles et al., 1983) and achievement goal theorists (Murphy & Alexander, 2000; Pintrich, 2003), research utilizing these frameworks has remained largely independent (Pintrich, 2003). Further, no framework has explicitly connected the different conceptualizations of task values and the different conceptualizations of achievement goals (Pintrich, Ryan, & Patrick, 1998). The research presented in this dissertation provides some initial insight into how achievement goals and task values might be inter-related, and future research will need to continue to examine these relationships.

This study also extends prior research and theorizing on the role of value in interest development. Because we only examined interest at two time points (initial and final), any conclusions we draw regarding the development of interest must be tentative. Nonetheless, we controlled for initial levels of interest before the intervention, and thus growth in interest at the end of the semester can be assessed. Importantly, we did find that utility value played a causal role in the development of interest over the course of a laboratory session or academic semester. In the exploratory analysis offered in Study 3, we examined the role of utility value processes in fostering interest over time. This type of developmental analysis, although covering just a few months, is an important initial examination of the process model of interest development offered by Hidi and Renninger (2006). Perceived utility value was a key contributor in the development of interest over the course of the semester, and the process analysis from Study 3 highlighted the important roles of involvement and identification in promoting continued interest in a topic.

Future Directions

Given the success of this intervention, it is now possible to consider how students might be taught to implement this type of strategy on their own. Sansone and her colleagues have developed a line of research that investigates how students utilize interest-enhancing strategies in order to maintain and increase their motivation for tasks and activities (Sansone & Thoman, 2005; Sansone, Weir, Harpster, & Morgan, 1992). These strategies involve increasing the challenge of the activity, paying attention to interesting features of the environment, and introducing variety to the task (Sansone et al., 1992). A fourth strategy is to maintain interest "through the self-provision of relevant values and long-term goals (p. 253)" (Green-Demers, Pelletier, Stewardt, & Gushue, 1998). Essentially, this strategy involves finding some type of usefulness and utility value in the task. Incorporating this line of research with the current findings could produce interesting new intervention studies. For example, a program could be developed that trains students to make connections to the course material on their own during lectures, classroom activities, when reading the material, etc., such that it becomes a skill that they do automatically. In the current research design, follow-up investigations could assess whether students in the relevance conditions report making more connections in their future courses than students in the control conditions.

I also intend to follow the high school students in Study 3 through graduation. With the cooperation of the Madison Metropolitan School District, I will be able to track their course choices, grades, standardized test scores, graduation rates, and attendance. Thus, I will be able to track the long-term effects of this intervention on students' behavioral measures of interest in science, persistence in school, and performance. I could also use student demographic information from the school district to investigate additional moderators of the treatment effect, such as prior achievement, socio-economic status, and ethnicity. Student and teacher-level data could also be used to further assess the variability in effects found across classrooms, teachers, and schools.

Implications for Practice

The results of this research should be heartening to educators who desire to enhance the motivation of their students. The intervention was effective in enhancing interest and performance by increasing student involvement and identification with the course material. Contrary to the established downward trajectory of student interest, this intervention lead to the development of interest – in comparison to a control group – over the course of the semester. It was easy and inexpensive to implement, produced effects in as few as one or two trials, was effective with college undergraduates and high school students alike, can be done during class or on the students own time, and is not specific to particular course material. That is, the utility value intervention can be applied to any topic or curriculum area. In our research, for example, participants wrote about the relevance of a new mental math technique, psychology, and biology. There is no reason to assume that similar results can not be obtained in other domains, such as history, English, or chemistry.

In addition, the students who most often concern teachers – those with low perceived and actual ability – benefited the most, and those with high perceived and actual ability were not harmed. These results parallel the positive effects of other successful psychological interventions intended to diminish the racial achievement gap in school performance (Cohen, Garcia, Apfel, & Master, 2006), and could point the way for more comprehensive efforts aimed to increase student motivation and performance to include psychological interventions along with curricular-based reforms. Thus, by integrating randomized experiments with a classroom-based intervention, we were able to understand how educators can promote interest and learning in the classroom.

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Appendix A – Scale items for Study 1

Participants responded to all self-report items in this study on a 7-point Likert-type scale from 1 (*strongly disagree*) to 7 (*strongly agree*).

Initial Interest (α = .93)

I find math enjoyable

Math just doesn't appeal to me. (reversed)

I enjoy working on math problems.

I like learning new math concepts.

Perceived Competence (α = .74)

I felt that I was using the technique correctly on the practice problems.

I felt that I was doing poorly on the practice problems. (reversed)

Utility Value (α = .84)

This technique could be useful in everyday life,

I don't think this technique would be useful to me in the future. (reversed)

To be honest, I don't think this technique is useful. (reversed)

Final Interest (α = .89)

The left-to-right technique is interesting.

Using this multiplication technique is fun.

It was a waste of time to learn this technique. (reversed)

I enjoyed using the left-to-right technique.

The learning program was enjoyable.

Appendix B - Scale items for Study 2

Participants responded to all self-report items in this study on a 7-point Likert-type scale from 1 (*strongly disagree*) to 7 (*strongly agree*).

Initial Interest ($\alpha = .91$)

I think psychology is an interesting subject.

I am not interested in psychology. (reversed)

I think I will like learning about psychology in this course.

I think psychology will be interesting.

I've always wanted to learn more about psychology.

Utility Value (Initial, $\alpha = .78$; Perceived, $\alpha = .88$)

What I am learning in this class is relevant to my life.

I think what we are studying in Introductory Psychology is useful for me to know.

I find the content of this course to be personally meaningful.

Initial Intrinsic Value ($\alpha = .89$)

Lectures in this class are entertaining.

I enjoy coming to lecture.

Lectures in this class drag on forever. (reversed)

Mastery-approach goals ($\alpha = .83$)

My goal in this class is to learn as much as I can.

The most important thing for me is to understand the content of this class as thoroughly as possible.

I want to learn as much as possible in this class.

Performance-approach goals (α = .82)

It is important for me to do well compared to other students in this class.

My goal in this class is to get a better grade than most of the other students.

I really don't care how I do compared to other students in this class. (reversed)

Final Interest (α = .93)

I think the field of psychology is very interesting.

I think what we're learning in this class is fascinating.

To be honest, I just don't find psychology interesting. (reversed)

I think the material in this course is boring. (reversed)

Psychology fascinates me.

Inclination

I am interested in majoring in psychology.

Appendix C – Scale Items for Study 3

Participants responded to all self-report items in this study on a 5-point Likert-type scale from 1 (*strongly disagree*) to 5 (*strongly agree*).

Perceived Ability ($\alpha = .73$)

I expect to do well in this class.

Considering the difficulty of this course and my skills, I think I will do well in this class.

Interest (Initial, Final) ($\alpha = .86$; $\alpha = .84$)

I think the field of science is interesting.

To be honest, I just don't find science interesting.

I think what we're learning in this class is interesting.

Utility Value (Initial $\alpha = .82$; Perceived $\alpha = .82$)

I can apply what we are learning in science class to real life.

I think what we are studying in science class is useful to know.

I can see how what I learn from science applies to life.

Mastery-approach goals ($\alpha = .86$)

I want to learn as much as possible in this class.

My goal in this class is to learn as much as I can.

Mastery-avoidance goals ($\alpha = .46$)

My goal this semester is to avoid learning less than I possibly could.

I just want to avoid learning less than I have in other courses.

Performance-approach goals ($\alpha = .86$)

I want to do better than other students in this class.

It is important for me to do well compared to other students in this class.

Performance-avoidance goals ($\alpha = .65$)

My goal in this class is to avoid doing poorly compared to others.

I just want to avoid doing worse than other students in this class.

Involvement ($\alpha = .73$)

In this class, I feel like I get involved with doing the assignments.

In this class, we learn the material through "hands on" activities, such as labs.

I play an active role in my learning in this class.

This class allows us to discover things on our own instead of just being told.

Identification ($\alpha = .86$)

Science class is important because it helps me become the person I want to be.

Science class is important because it will help me reach my future goals.

Future Plans ($\alpha = .84$)

My experience in this class makes me want to take more science courses.

I want to have a job that involves science some day.

I plan on taking more science courses even when I don't have to.

I am not really interested in using science in my future career.

Appendix D – Relevance Intervention for Study 2

<u>Control 1: PsycINFO project</u>

The purpose of this project is to permit you to explore additional research on some topic of relevance to Unit 2. It is especially intended to help you connect to the actual research that is being conducted in psychology, and to have an introduction to the main electronic database called PsycINFO.

The assignment:

(1) Select a concept or issue that is covered in this unit (Unit 2: Chapters 5 - 8) and formulate a question (e.g., What is the impact of a particular drug on synaptic activity? What is the impact of sleep loss on a particular cognitive activity? What factors influence the perception of motion in the visual system? How might expectations influence our perception of pain?)
(2) Use the PsycINFO database to find two abstracts that relate to your question. It is best to select abstracts that are as similar as possible to each other. Note that you need not find the whole article – the abstract is all that you need for this assignment.
(3) Write a 1-2 page typewritten summary of these abstracts. Be sure to address the following points:
    a. List the complete bibliographic reference for these articles using the same format that Gray does: Here is a sample reference format:
        Bukowski, W. M., Sippola, L. K. & Newcomb, A. F. (2000). Variations in patterns of attraction of same- and other-sex peers during early adolescence. <u>Developmental Psychology, 36</u>, 147-154.
    b. Identify the kind of research design employed in each article (e.g., true experiment, quasi, or correlational).
    c. Describe the procedures used in each investigation and briefly summarize the outcomes.
    d. Compare and contrast the findings from the two abstracts, including a discussion of how the findings relate to and expand upon what was covered in this unit in class and text.

<u>Control 2: Outline</u>

The purpose of this project is to help in the comprehension and understanding of some major concept used in this unit. It is especially intended to help you understand one particular topic from this unit in detail.

(1) Select a concept or issue that is covered in this unit (Unit 2: Chapters 5 - 8) and formulate a question (e.g., What is the impact of a particular drug on synaptic activity? What is the impact of sleep loss on a particular cognitive activity? What factors influence the perception of motion in the visual system? How might expectations influence our perception of pain?)
(2) Select the relevant information from class notes and the textbook.
(3) Create a 1-2 page typewritten outline of this topic. You should attempt to organize the material in a meaningful way, rather than simply listing the main facts or research findings. Remember to summarize the material in your own words.

Relevance 1: Media

The purpose of this project is to help in the comprehension and understanding of some major concept used in this unit. It is especially intended to help you see connections between what we cover in the course and issues that appear in the public media.

(4) Select a concept or issue that is covered in this unit (Unit 2: Chapters 5 - 8) and formulate a question (e.g., What is the impact of a particular drug on synaptic activity? What is the impact of sleep loss on a particular cognitive activity? What factors influence the perception of motion in the visual system? How might expectations influence our perception of pain?)
(5) Find a report in the media (magazines, newspapers, television, radio, internet, commercials) that pertains to the issue identified above.
(6) Write a 1-2 page typewritten analysis of the report. Be sure to address the following three issues:
    a. Identify the source (referencing it as completey as possible) and briefly summarize the report. Is there a claim that the information is empirically derived (e.g., from a research investigation)? What are the conclusions or message that was conveyed?
    b. Provide a brief critique of the report. How was the information acquired or supported? Is there distortion, inaccuracies, or biases that might affect the report? How might the report be improved? Think about cautions that might be introduced, qualifiers, documentation, etc.
    c. Discuss the relevance of the material to the present unit. How does it fit in or concur with the information presented here? Does it extend, modify, or revise information that we have covered?

Relevance 2: Letter

The purpose of this project is to help in the comprehension and understanding of some major concept used in this unit. It is especially intended to help you make personal applications of the concepts in this unit.

(1) Select a concept or issue that is covered in this unit (Unit 2: Chapters 5 - 8) and formulate a question (e.g., What is the impact of a particular drug on synaptic activity? What is the impact of sleep loss on a particular cognitive activity? What factors influence the perception of motion in the visual system? How might expectations influence our perception of pain?)
(2) Think of a person who might be interested in this topic (e.g., a friend, relative, or a significant other).
(3) Write a 1-2 page typewritten letter describing the issue and the relevance of the material to this other person. Don’t assume that the other person has a technical understanding of psychology, but describe the process in some detail using plain language that a layperson would understand. Be sure to include some concrete information or research findings that were covered in this unit, explaining why the information is relevant to this person’s life.

Appendix E – Relevance Intervention for Study 3

Control Group

Unit Review Activity

Now that we have reviewed the main topics and concepts from this unit, it is time to reflect on one specific topic or concept.

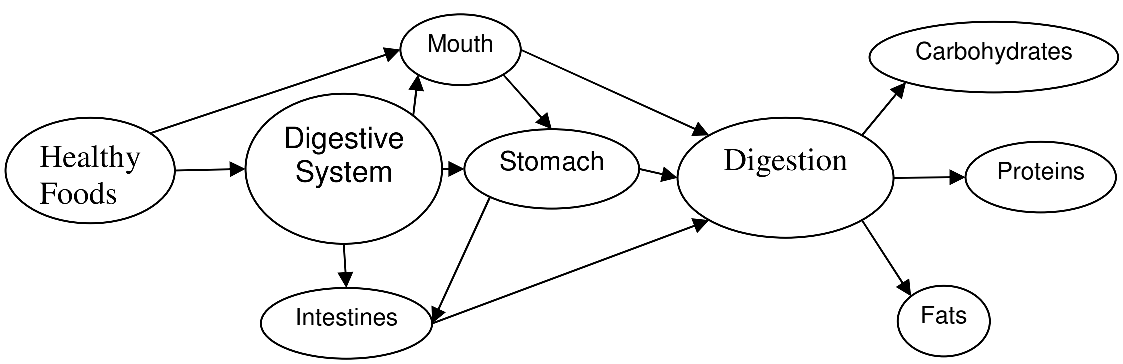
Part A: Pick one of the topics or concepts that we have covered in this unit.

Part B: Summarize main parts of this topic/concept.

You can either: 1) write about it in at least 5 sentences, 2) draw a concept map with a description, or 3) draw a sketch with a description. If you do a concept map or a sketch, be sure to describe it well enough so that the reader can understand it.

For example, if you were studying nutrition, you could choose a topic such as how food is digested. A written summary would include a description of the digestive system, and how foods are broken down in the mouth, stomach, and intestines. This process is called digestion. Food is broken down into carbohydrates, proteins, and fats.

You could also draw a concept map of the digestive system. An example is provided below. Remember that you would also need to add a brief written description with a concept map or diagram.



Remember: Do both Part A (pick a topic) and Part B (summarize the main parts).

The unit we are studying is: ____

Part A: The topic/concept I pick is: ____

Part B: My summary and review (use the back side if needed):

Relevance Group

Unit Review Activity

Now that we have reviewed the main topics and concepts from this unit, it is time to reflect on one specific topic or concept.

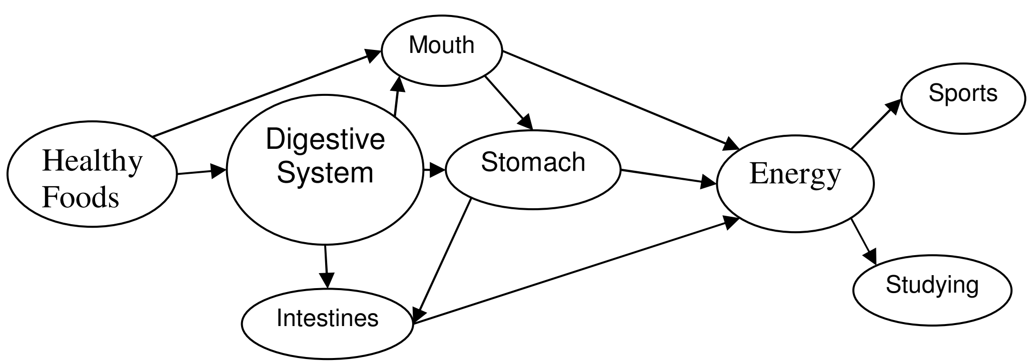
Part A: Pick one of the topics or concepts that we have covered in this unit and briefly summarize the main parts.

Part B: Apply this topic/concept to your life, or to the life of someone you know. How might the information be useful to you, or a friend/relative, in daily life? How does learning about this topic apply to your future plans?

You can either: 1) write about it in at least 5 sentences, 2) draw a concept map with a description, or 3) draw a sketch with a description. If you do a concept map or a sketch, be sure to describe it well enough so that the reader can understand it.

For example, if you were studying nutrition, you could choose a topic such as how food is digested. Briefly summarize the digestive process—how foods are broken down in the mouth, stomach, and intestines to make energy. Then you could write about how this applies to your own life. For example, eating healthy foods helps your body produce energy to play your favorite sport or study for exams.

You could also draw a concept map of how your knowledge of digestion applies to your life. An example is provided below. Remember that you would also need to add a brief written description with a concept map or diagram.



Remember: Do both Part A (pick a topic and summarize) and Part B (apply it to life).

The unit we are studying is: ____

Part A: The topic/concept I pick is: _______________________________________

My brief summary:

Part B: My application to life (use the back side if needed):

Footnotes

1. In this paper, “ability perceptions”, “competence beliefs”, and “success expectancies” all refer to the self-perception of how well one can perform a specific activity or task. Although an in-depth discussion of the similarities and differences among these terms is beyond the scope of this paper, there is enough overlap to warrant equating these constructs for our purposes (Pintrich, 2003). The interested reader is referred to more detailed discussions in Bandura (1997), Elliot & Dweck (2005), and Pintrich (2003).
2. Although Mitchell uses these terms to refer to holding situational interest, here I am characterizing them as processes instigated by perceptions of utility value.
3. We tested for differences between the two sets of pictures, and after failing to detect them, combined participants who wrote about math-related and art-related pictures into one control writing condition.
4. The Nagelkerke R^2 is an approximation of the R^2 typically used in ordinary least squares (OLS) regression (Cohen, Cohen, Aiken, & West, 2003).
5. Due to time and space limitations we only assessed the approach forms of these goals in Study 2, whereas in Study 3 we assessed the complete 2 x 2 model of achievement goals.
6. Because I do not yet have the district data, I was only able to obtain grades for a sub-set of the entire sample (N = 273). As a result, the analyses on grades included only those students for whom I have both grades and measures on the initial variables (N = 200).
7. Because there are only three schools, we do not have enough variability to add a fourth level to the model.

8. We created a series of dummy codes to represent classrooms (21), teachers (9), and schools (3). We arbitrarily chose one classroom, teacher, and school to be the control group, and created 20 classroom dummy variables, 8 teacher dummy variables, and 1 school contrast code (-1, 0, 1). By including these dummy variables and interacting each of them with the treatment, the effects of clustering are removed from the coefficient estimates and the slopes. This strategy limits the generalizability of the findings, because the effects are fixed rather than random, but adjusts the standard errors for clustering (Raudenbush & Bryk, 2002).
9. Refers to a standardized regression coefficient. This measure can be used as one measure of strength of association (Cohen et al., 2003).
10. Although student demographic information was to be provided by the Madison Metropolitan School District, we are currently unable to access this information (August, 2007).

Table 1

Zero-order correlations and descriptive statistics for major variables in Study 1

		1	2	3	4	5	6	7	8	9
1	Initial Interest	0.93								
2	Perceptions of Competence	0.23	0.74							
3	Initial Performance	0.24	0.55	--						
4	Writing Condition	-0.03	0.22	0.09	--					
5	Observed Utility Value	-0.13	0.12	0.05	0.88	--				
6	Perceived Utility Value	0.07	0.23	0.15	0.21	0.31	0.84			
7	Final Interest	0.24	0.37	0.22	0.27	0.28	0.72	0.89		
8	Inclination	0.04	0.20	0.11	0.30	0.37	0.68	0.57	--	
9	Final Performance	0.25	0.46	0.83	0.07	0.06	0.18	0.28	0.17	--
	Minimum	1.00	1.00	0.00	0.00	-0.99	1.75	1.00	0.00	0.00
	Maximum	7.00	7.00	24.0	1.00	1.89	7.00	7.00	1.00	39
	Mean	4.12	4.87	10.2	0.57	0.00	5.10	4.89	0.78	22.5
	SD	1.43	1.29	5.09	0.50	0.98	1.10	1.04	0.42	7.46

N = 107. Scale reliabilities are presented along the diagonal where applicable. Items ranged from 1 (*low*) to 7 (*high*) except for Initial Performance (from 0 to 24 problems), Writing Condition (from 0 = control to 1 = relevance), Inclination (from 0 = no to

1 = yes), Observed Utility Value (from 0 = not present to 3 = present – high quality), and Final Performance (from 0 to 39 problems).

Correlations greater than .19 are significant at $p < .05$. Correlations greater than .23 are significant at $p < .01$

Table 2

Descriptive Statistics by Experimental Condition for Major Variables in Study 2

		PsycINFO	Outline	Media	Letter	Total	F
Observed Utility	Mean	0.26	0.38	0.39	1.56	0.64	96.75**
	N	80	78	82	78	318	
	SD	0.46	0.56	0.46	0.68	0.76	
Pronouns	Mean	2.61	2.58	5.87	28.99	9.91	213.69**
	N	80	78	82	78	318	
	SD	3.20	4.33	4.38	13.24	13.23	
Observed Relevance	Mean	-0.51	-0.45	-0.30	1.35	0.01	206.74**
	N	78	74	82	76	310	
	SD	0.36	0.46	0.42	0.81	0.93	
Essay Grade	Mean	4.06	4.46	4.10	4.19	4.20	6.51**
	N	80	78	82	78	318	
	SD	0.76	0.48	0.55	0.69	0.65	
Initial Interest	Mean	4.62	4.71	4.86	4.83	4.75	1.58
	N	71	74	75	72	292	
	SD	0.86	0.79	0.68	0.65	0.75	
Initial Utility	Mean	4.57	4.68	4.68	4.53	4.62	0.37
Value	N	68	71	70	63	272	
	SD	1.07	1.10	0.91	1.12	1.05	
Initial Intrinsic	Mean	3.98	4.06	4.20	4.16	4.10	0.41
Value	N	68	71	70	63	272	
	SD	1.19	1.34	1.25	1.26	1.26	
Mastery approach	Mean	5.26	5.27	5.41	5.16	5.28	0.62
	N	68	71	70	63	272	

		PsycINFO	Outline	Media	Letter	Total	F
	SD	1.04	1.18	0.99	1.07	1.07	
Performance	Mean	5.54	5.70	5.46	5.39	5.53	0.83
approach	N	68	71	70	63	272	
	SD	1.21	1.18	1.18	1.41	1.24	
Perceived Utility	Mean	4.39	4.49	4.69	4.67	4.56	1.10
Value	N	69	71	72	60	272	
	SD	1.22	1.10	1.09	1.16	1.15	
Final Interest	Mean	3.92	3.94	4.53	4.33	4.18	3.77**
	N	69	71	72	60	272	
	SD	1.47	1.25	1.11	1.29	1.30	
Inclination	Mean	2.31	2.29	2.53	2.45	2.39	0.19
	N	68	68	72	58	266	
	SD	1.81	1.68	1.91	1.94	1.82	
Initial Exams	Mean	88.83	92.27	90.02	90.88	90.48	0.89
	N	80	78	82	78	318	
	SD	13.77	12.69	14.89	13.32	13.70	
Final Grade	Mean	2.63	2.92	2.72	2.76	2.75	1.39
	N	80	78	82	78	318	
	SD	0.89	0.83	0.91	0.95	0.90	
Sex	Mean	0.63	0.63	0.62	0.66	0.64	0.07
	N	79	76	82	73	310	
	SD	0.49	0.49	0.49	0.48	0.48	

Observed Utility = amount of utility value that students wrote about in their essays. Pronouns = number of personal pronouns used in student's essays. Essay Grade = average number of points assigned by the instructor for each of the two essays. Initial Interest = initial interest in psychology at the beginning of the semester. Initial Utility Value = perceived utility value for psychology at the beginning of the semester. Initial Intrinsic Value = perceived intrinsic value in psychology at the beginning of the semester. MAp = mastery approach goals. PAp = performance approach goals. Perceived Utility Value = perceived utility value for psychology at the end of the semester. Final Interest = interest in psychology at the end of the semester. Initial Exams = the average of the first two exam grades. Final Grade = final psychology course grade. Sex = 0 (Male), 1 (Female).

Table 3

Correlations Between Major Variables in Study 2

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Value	--														
2	Letter	-0.04	--													
3	Outline	-0.04	0.00	--												
4	Obs. Relevance	0.50	0.62	0.00	0.86											
5	Essay Grade	-0.08	0.04	0.18	0.01	--										
6	Initial Interest	0.09	-0.02	0.03	0.03	0.06	0.91									
7	Initial Utility	0.05	-0.09	0.03	-0.08	-0.05	0.53	0.78								
8	Initial Intrinsic	0.06	0.03	0.02	0.03	-0.08	0.51	0.55	0.89							
9	Map	0.01	-0.12	0.00	-0.05	0.02	0.46	0.38	0.41	0.83						
10	PAp	-0.05	-0.01	0.02	-0.02	0.15	-0.09	-0.07	-0.11	0.02	0.82					
11	Perceived Utility	0.10	0.00	0.04	0.06	0.07	0.50	0.56	0.47	0.46	0.02	0.88				
12	Final Interest	0.19	-0.05	0.03	0.12	0.10	0.57	0.45	0.51	0.45	0.00	0.70	0.93			
13	Inclination	0.04	-0.03	0.00	0.02	0.02	0.37	0.32	0.25	0.29	-0.02	0.43	0.44	--		
14	Initial Exams	0.04	0.07	0.10	0.08	0.23	-0.07	0.03	-0.04	-0.09	-0.01	0.18	0.12	0.03	0.80	
15	Final Grade	0.02	0.05	0.10	0.06	0.29	-0.05	0.01	-0.05	-0.08	0.02	0.15	0.09	-0.01	0.90	--
16	Sex	0.03	0.01	0.04	0.03	0.07	0.25	0.08	0.00	0.00	-0.03	0.13	0.18	0.06	0.06	0.08

N = 237. Scale reliabilities are presented along the diagonal where applicable. Value = + 1 (Relevance Writing Conditions: Letter, Media), - 1 (Control Writing Conditions: Outline, Summary). Letter = +1 (Letter), -1 (Media). Outline = +1 (Outline), -

1 (Summary). Obs. Relevance = combined degree of utility value and number of pronouns that students wrote about in their essays. Essay Grade = average number of points assigned by the instructor for each of the two essays. Initial Interest = initial interest in psychology at the beginning of the semester. Initial Utility = perceived utility value for psychology at the beginning of the semester. Initial Intrinsic = perceived intrinsic value in psychology at the beginning of the semester. MAp = mastery approach goals. PAp = performance approach goals. Perceived Utility = perceived utility value for psychology at the end of the semester. Final Interest = interest in psychology at the end of the semester. Inclination = interest in majoring in Psychology. Initial Exams = the average of the first two exam grades. Final Grade = final psychology course grade. Sex = 0 (Male), 1 (Female).

Table 4

Mean Differences by Experimental Condition for Initial and Coding Variables in High School Science Classes (Study 3)

		Control	Relevance	Overall	*t*	*p*	*d*
Perceived Ability	Mean	4.24	4.16	4.20	1.21	0.23	0.12
	N	186	191	377			
	SD	0.69	0.72	0.70			
Initial Interest	Mean	4.19	3.99	4.09	1.97	0.05	0.20
	N	186	191	377			
	SD	0.94	0.98	0.96			
Initial Utility Value	Mean	3.44	3.36	3.40	0.98	0.33	0.10
	N	185	191	376			
	SD	0.86	0.86	0.86			
Mastery approach	Mean	4.16	3.99	4.07	1.66	0.10	0.17
	N	180	18	368			
	SD	0.91	1.00	0.96			
Performance approach	Mean	3.70	3.55	3.62	1.31	0.19	0.14
	N	180	188	368			
	SD	1.02	1.11	1.07			
Mastery avoidance	Mean	2.75	2.80	2.77	-0.47	0.64	-0.05
	N	178	188	366			

		Control	Relevance	Overall	*t*	*p*	*d*
	SD	1.06	1.10	1.08			
Performance avoidance	Mean	3.71	3.64	3.68	0.63	0.53	0.07
	N	180	188	368			
	SD	1.01	1.06	1.03			
Observed Relevance	Mean	-0.45	0.47	0.01	13.56	< .01	1.29
	N	248	245	493			
	SD	0.48	0.96	0.88			
Essay Quality	Mean	1.81	1.81	1.81	0.19	0.85	0.02
	N	211	213	424			
	SD	0.38	0.36	0.37			
Sentences	Mean	4.14	3.66	3.90	2.51	0.01	0.24
	N	211	21	424			
	SD	2.18	1.78	2.00			
Number of Essays	Mean	3.98	3.93	3.95	0.28	0.78	0.03
	N	213	215	428			
	SD	1.72	1.72	1.72			

Note: Perceived Ability = perceptions of ability and performance expectations in science. Mastery approach = Mastery approach goals. Performance approach = Performance approach goals. Mastery avoidance = Mastery avoidance goals. Performance avoidance = Performance avoidance goals. Observed Relevance = average of coders essay ratings of utility value and pronouns. Essay Quality = average coder ratings of essay quality. Sentences = average number of sentences in each essay. Number of Essays = average number of essays written.

Table 5

Frequency Table of Number of Essays Written in Study 3

Number of essays completed	Frequency	Percent	Cumulative Percent
0	3	0.7	0.7
1	37	8.6	9.3
2	44	10.3	19.6
3	82	19.2	38.8
4	88	20.6	59.3
5	131	30.6	90.0
6	7	1.6	91.6
7	16	3.7	95.3
8	20	4.7	100
Total	428	100	

Table 6

Correlations Between Major Variables in High School Science Classes (Study 3)

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Perceived Ability	--																
2	Initial Interest	0.36	--															
3	Initial Utility	0.38	0.57	--														
4	Map	0.44	0.60	0.56	--													
5	Mav	0.08	0.12	0.12	0.11	--												
6	Pap	0.39	0.23	0.36	0.43	0.12	--											
7	Pav	0.22	0.17	0.25	0.37	0.16	0.61	--										
8	Writing Condition	-0.06	-0.10	-0.05	-0.09	0.02	-0.07	-0.03	--									
9	Perceived Utility	0.34	0.41	0.56	0.47	-0.04	0.30	0.17	-0.10	--								
10	Involvement	0.30	0.27	0.27	0.33	0.01	0.22	0.18	-0.10	0.61	--							
11	Identification	0.29	0.43	0.42	0.40	0.08	0.25	0.06	-0.06	0.61	0.42	--						
12	Observed Relevance	0.00	-0.06	-0.02	-0.10	0.13	-0.05	0.02	0.54	0.02	0.01	0.05	--					
13	Essay Quality	0.21	0.07	0.10	0.07	0.06	0.07	0.05	-0.01	0.21	0.30	0.20	0.27	--				
14	Sentences	0.23	0.15	0.19	0.18	0.14	0.13	0.00	-0.12	0.22	0.20	0.16	0.17	0.56	--			
15	Number of Essays	0.24	0.16	0.15	0.19	0.12	0.13	0.03	-0.01	0.10	0.11	0.10	0.01	0.26	0.19	--		
16	Final Interest	0.26	0.54	0.33	0.37	0.05	0.16	0.02	-0.14	0.55	0.42	0.50	-0.02	0.14	0.12	0.14	--	
17	Future Plans	0.30	0.49	0.32	0.33	0.15	0.22	0.03	-0.09	0.46	0.35	0.60	0.05	0.10	0.14	0.10	0.71	--
18	Grade	0.26	0.12	0.18	0.14	0.10	0.17	0.07	-0.05	0.20	0.29	0.24	0.15	0.40	0.38	0.51	0.29	0.27

N = 296. Notes: MAp = Mastery approach goals. PAp = Performance approach goals. MAv = mastery avoidance goals. PAv = Performance avoidance goals. Writing Condition (0 = control, 1 = relevance).

Table 7

Exploratory Factor Analysis on Process Measures in Study 3

Items	*Involvement*	*Identification*	*Perceived Utility Value*
In this class, we learn the material through "hands on" activities, such as labs.	**0.689**	0.047	0.094
This class allows us to discover things on our own instead of just being told.	**0.576**	0.068	-0.192
In this class, I feel like I get involved with doing the assignments.	**0.555**	-0.166	-0.071
I play an active role in my learning in this class.	**0.423**	-0.181	-0.154
Science class is important because it will help me reach my future goals.	-0.009	**-0.867**	-0.004
Science class is important because it helps me become the person I want to be.	-0.010	**-0.859**	0.000
I can apply what we are learning in science class to real life.	-0.021	0.036	**-0.809**
I can see how what I learn from science applies to life.	0.063	-0.102	**-0.771**
I think what we are studying in science class is useful to know.	0.242	-0.277	**-0.341**
Factor Correlations			
Identification	-0.39		
Utility Value	-0.61	0.64	

Table 8

Multilevel models predicting Study 3 outcomes

	Final Interest			**Future Plans**			**2nd Quarter Grade**		
	Direct	*Mediation*		*Direct*	*Mediation*		*Direct*	*Mediation*	
	Effects	*(Utility)*	*(All)*	*Effects*	*(Utility)*	*(All)*	*Effects*	*(Utility)*	*(All)*
Student Level Fixed Effects (β's)									
Treatment-related Effects									
Intercept	4.27***	4.16***	4.04***	3.67***	3.59***	3.39***	2.70***	2.82***	2.79***
	(0.20)	(0.18)	(0.18)	(0.21)	(0.22)	(0.20)	(0.15)	(0.17)	(0.17)
Group	-0.41	-0.21	-0.18	-0.05	0.00	0.12	-0.21	-0.54	-0.54
	(0.26)	(0.27)	(0.27)	(0.35)	(0.35)	(0.31)	(0.25)	(0.27)	(0.28)
Perceived	0.09	0.03	-0.03	0.25*	0.21	0.11	0.12	0.14	0.08
Ability (PA)	(0.12)	(0.11)	(0.11)	(0.14)	(0.14)	(0.13)	(0.23)	(0.24)	(0.23)
Group X PA	-0.11	0.02	0.06	-0.24	-0.09	-0.04	0.04	-0.04	0.10
	(0.18)	(0.19)	(0.18)	(0.21)	(0.21)	(0.19)	(0.34)	(0.34)	(0.10)
Initial Interest	0.38***	0.40***	0.41***	0.36***	0.38***	0.34***	0.19	0.21	0.13
	(0.10)	(0.09)	(0.09)	(0.11)	(0.11)	(0.10)	(0.16)	(0.17)	(0.17)
Group X	0.13	0.05	0.03	0.13	0.03	-0.01	-0.25	-0.25	-0.19
Initial Interest	(0.12)	(0.12)	(0.12)	(0.13)	(0.13)	(0.13)	(0.21)	(0.22)	(0.21)
Process Variables									
Perceived		0.40***	0.26***		0.38***	0.15*		0.09	-0.12
Utility Value		(0.07)	(0.08)		(0.08)	(0.09)		(0.14)	(0.15)

Observed		-0.02	-0.02		0.08	0.06		0.28**	0.29**
Relevance		(0.07)	(0.07)		(0.08)	(0.08)		(0.12)	(0.11)
Involved			0.18**			0.08			0.41**
			(0.08)			(0.09)			(0.16)
Identified			0.11**			0.37***			0.10
			(0.05)			(0.06)			(0.10)
Covariates									
Initial Utility	0.09	-0.06	-0.05	0.09	-0.06	-0.08	0.18	0.14	0.19
Value	(0.07)	(0.07)	(0.07)	(0.08)	(0.09)	(0.08)	(0.12)	(0.14)	(0.13)
Mastery	0.08	0.00	-0.03	0.09	-0.01	-0.02	-0.01	-0.02	-0.05
approach	(0.07)	(0.07)	(0.07)	(0.09)	(0.09)	(0.08)	(0.14)	(0.15)	(0.15)
Mastery	0.01	0.04	0.02	0.10*	0.12**	0.07	0.04	0.02	0.01
avoidance	(0.05)	(0.04)	(0.04)	(0.05)	(0.05)	(0.05)	(0.08)	(0.08)	(0.08)
Performance	0.06	0.02	< 0.01	0.18**	0.14**	0.07	0.14	0.15	0.16
approach	(0.06)	(0.06)	(0.06)	(0.07)	(0.07)	(0.07)	(0.11)	(0.12)	(0.11)
Performance	-0.07	-0.06	-0.05	-0.18***	-0.19**	-0.11*	0.06	0.04	0.01
avoidance	(0.06)	(0.05)	(0.05)	(0.06)	(0.07)	(0.06)	(0.10)	(0.11)	(0.08)
Classroom Level Random Effects (μ's)									
Intercept	0.02	0.02	0.02	< 0.01	< 0.01	< 0.01	0.04	0.06*	0.08*
Group	< 0.01	0.01	0.01	0.02	< 0.01	< 0.01	0.25**	0.16**	0.22**
Group X PA	0.14**	0.22***	0.20***	0.19**	0.22**	0.13**	0.42***	0.30**	0.29**
Group X Initial Interest	0.03	0.05**	0.05**	0.02**	0.02**	0.04***	0.04	0.06	0.07

Error	0.54	0.47	0.45	0.78	0.69	0.62	1.32	1.29	1.22
(R^2)	(0.43)	(0.51)	(0.53)	(0.34)	(0.43)	(0.49)	(0.20)	(0.27)	(0.31)
Teacher Random Effects (r's)									
Intercept	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Group	< 0.01	< 0.01	< 0.01	0.03	0.01	< 0.01	< 0.01	< 0.01	< 0.01
School Fixed Effects (π's)									
Intercept	-0.38**	-0.33**	-0.26**	-0.31*	-0.24	-0.11	-0.49	-0.42	-0.26
	(0.12)	(0.11)	(0.11)	(0.10)	(0.13)	(0.12)	(0.32)	(0.34)	(0.35)
Group	0.15	0.06	0.04	-0.04	-0.10	-0.20	-0.40	-0.11	-0.26
	(0.15)	(0.15)	(0.15)	(0.21)	(0.19)	(0.17)	(0.47)	(0.46)	(0.35)
Unconditional Model									
Level-1 Variance (% of total)	0.94*** (98)			1.19*** (98)			1.65*** (94)		
Level-2 Variance (% of total)	< 0.01 (< 1)			< 0.01 (< 1)			0.11*** (6)		
Level-3 Variance (% of total)	0.02* (2)			0.02* (2)			< 0.01 (< 1)		
Total Variance	0.95 (100)			1.22 (100)			1.76 (100)		
N	296			296			200		

Standard errors are in parentheses unless otherwise specified. *** p < .01. ** p < .05. * p < .10.

Table 9

Multilevel models predicting Study 3 mediational variables

	Perceived Utility Value	**Observed Relevance**	**Involvement**	**Identification**
Student Level Fixed Effects (β's)				
Treatment-related Effects				
Intercept	3.90***	-0.27	4.33***	3.75***
	(0.17)	(0.16)	(0.19)	(0.21)
Group	-0.53*	1.58***	-0.20	-0.41
	(0.26)	(0.31)	(0.21)	(0.37)
Perceived	0.13	-0.05	0.32***	0.25*
Ability (PA)	(0.11)	(0.10)	(0.09)	(0.13)
Group X PA	-0.38**	0.14	-0.41***	-0.32*
	(0.16)	(0.13)	(0.14)	(0.18)
Initial Interest	-0.03	0.03	-0.12*	0.12
	(0.08)	(0.08)	(0.07)	(0.10)
Group X Initial	0.24**	0.01	0.19**	.19
Interest	(0.10)	(0.09)	(0.09)	(0.13)
Covariates				
Initial Utility	0.41***	-0.04	0.09	0.26***
Value	(0.07)	(0.06)	(0.06)	(0.08)
Mastery	0.20***	-0.02	0.24***	0.12
approach	(0.06)	(0.06)	(0.05)	(0.08)
Mastery	-0.08*	0.08**	-0.00	0.09*
avoidance	(0.04)	(0.03)	(0.03)	(0.05)
Performance	0.10*	-0.01	-0.02	0.28***
approach	(0.06)	(0.05)	(0.04)	(0.07)
Performance	0.01	0.08*	0.06	-0.20***
avoidance	(0.05)	(0.04)	(0.04)	(0.06)
Classroom Level Random Effects (μ's)				
Intercept	0.01	0.00	0.02	0.00
Group	0.04	0.02	0.01	0.00
Group X PA	0.10	0.00	0.12***	0.03***

Group X Initial Interest	0.01	0.00	0.01	0.03
Error	0.41	0.38	0.34	0.70
(R^2)	(0.52)	(0.45)	(0.30)	(0.40)
Teacher Random Effects (*r*'s)				
Intercept	< .01	0.00	0.01*	0.01*
Group	0.01	0.05**	0.01	0.05
School Fixed Effects (π's)				
Intercept	-0.15	-0.12	-0.30**	-0.37**
	(0.10)	(0.09)	(0.11)	(0.12)
Group	0.27	-0.41***	0.07	0.29
	(0.15)	(0.18)	(0.12)	(0.21)
Unconditional Model Variance				
Level-1	0.79***	.69***	.48***	1.16***
(% of total)	(99)	(92)	(92)	(97)
Level-2	< .01	< .01	.02*	.02
(% of total)	(< 1)	(< 1)	(5)	(1)
Level-3	< .01	.06**	.01*	.01
(% of total)	(< 1)	(8)	(3)	(1)
Total	0.79	0.75	0.52	1.19
	(100)	(100)	(100)	(100)

N = 296. Standard errors are in parentheses unless otherwise specified.
*** p < .01. ** p < .05. * p < .10.

Table 10

Summary of utility intervention effects across all three studies

		Dependent Variables				Mediators			
	Predictors	Interest	Inclination	Performance	Observed Utility Value	Perceived Utility Value	Involvement	Identification	Mean
Study 1	Treatment	0.24*	0.30*	0.03	0.87*	0.19*	--[b]	--[b]	0.33
	Low PA	0.45*	0.61*	--[a]	0.98*	0.48*	--[b]	--[b]	0.63
	High PA	0.03	-0.02	--[a]	0.76*	0.10	--[b]	--[b]	0.22
Study 2	Treatment	0.15*	0.01	0.01	0.52*	0.08	--[b]	--[b]	0.15
	Low PA	0.29*	--[a]	--[a]	--[a]	0.20*	--[b]	--[b]	0.28
	High PA	0.01	--[a]	--[a]	--[a]	0.04	--[b]	--[b]	0.17
Study 3	Treatment	-0.09	-0.10	-0.06	0.60*	-0.07	0.05	0.08	0.06
	Low PA	--[a]	--[a]	--[a]	--[a]	0.20*	0.18*	0.19*	0.16
	High PA	--[a]	--[a]	--[a]	--[a]	-0.06	-0.09	-0.04	0.04
Mean	Treatment	0.10	0.07	-0.01	0.66*	0.07	0.05	0.08	0.15
	Low PA	0.22*	0.17*	--[a]	--[a]	0.29*	0.18*	0.19*	0.29
	High PA	0.02	-0.02	--[a]	--[a]	0.03	-0.09	-0.04	0.09

Values are standardized regression coefficients for the main effect of the utility intervention (“Treatment”), as well as for the interaction between the intervention and Perceptions of Ability (PA). Low PA = one standard deviation below the mean of

Perceived Ability. High PA = one standard deviation above the mean of Perceived Ability. Marginal Means are calculated as the average of the values in the corresponding rows or columns. If the interaction was not significant, then the main effect was entered in its place.

[a] The interaction was not significant, so these slopes were not calculated.

[b] Not applicable: Involvement and Identification were not measures in Study 1 or 2.

* $p < .05$.

Table 11

Summary of mediator effects across all three studies

		Dependent Variables			
		Interest	Inclination	Performance	Mean
Study 1	Utility Value	0.67*	0.59*	0.13	0.46
Study 2	Utility Value	0.53*	0.39*	0.36*	0.43
Study 3	Utility Value	0.35*	0.30*	0.16	0.27
	Mean	0.52	0.43	0.22	0.39
Study 3	Utility Value	0.21*	0.07	-0.05	0.08
(with other	Involvement	0.11*	0.06	0.26*	0.14
mediators)	Identification	0.15*	0.40*	0.10	0.22

Values are standardized regression coefficients from simultaneous multiple regressions.

Marginal Means are the average across each row or column.

* $p < .05$.

Figure Captions

Figure 1. Path model of utility value effects on interest and performance.

Figure 2 . Path model of utility value effects on interest and performance moderated by perceived ability.

Figure 3. Interactive effects of the relevance manipulation and perceived competence on Study 1 outcomes. 3A. Final Interest. 3B = Inclination. 3C = Perceived Utility Value.

Figure 4. Direct effects path model on Study 1 outcomes. Paths represent standardized regression coefficients and are significant at $p < .05$. Superscripts [a, b, c, d] indicate a significant interaction with Perceived Competence and are represented with “Lo” (Low Perceived Competence) and “Hi” (High Perceived Competence). For example, the direct effect of the manipulation on Observed Relevance (B = .89) was moderated by a significant interaction with Perceived Competence (Low Perceived Competence B = .98, High Perceived Competence B = .76).

Figure 5. Mediational path model on Study 1 outcomes. Paths represent standardized regression coefficients and are significant at $p < .05$. Significant interactions between the manipulation and Perceived Competence are represented with “Lo” (Low Perceived Competence) and “Hi” (High Perceived Competence).

Figure 6. Interactive effects of the relevance manipulation and Initial Exams on Study 2 outcomes. 6A = Final Interest. 6B = Perceived Utility Value.

Figure 7. Direct effects path model for Study 2. Solid paths are standardized regression coefficients significant a p < .05, unless otherwise indicated. * Direct effect of the manipulation on Perceived Utility Value is non-significant ($p = .12$). Superscripts [a, b] indicate a significant

interaction with Initial Exams and are represented with “Lo” (Low Initial Exams) and “Hi” (High Initial Exams).

Figure 8. Overall path model on Study 2 outcomes. All paths are standardized coefficients from a multiple regression model and are significant at $p < .05$. Dashed paths are not significant ($p > .10$) and are presented for comparative purposes. Significant interactions between the manipulation and Initial Exams are represented with “Lo” (Low Initial Exams) and “Hi” (High Initial Exams).

Figure 9. Direct effects path model for Study 3. All paths are standardized coefficients from a multiple regression model and are significant at $p < .05$. Dashed paths are not significant ($p > .10$) and are presented for comparative purposes. Significant interactions between the manipulation and Perceived Ability are represented with “Lo” (Low Perceived Ability) and “Hi” (High Perceived Ability).

Figure 10. Utility perceptions path model on Study 3 outcomes. Solid paths are standardized regression coefficients significant a $p < .05$. Dashed paths are non-significant (p’s > .15). Significant interactions between the manipulation and Perceived Ability are represented with “Lo” (Low Perceived Ability) and “Hi” (High Perceived Ability).

Figure 11. Overall path model on Study 3 outcomes. Solid paths are standardized regression coefficients significant a $p < .05$. Dashed paths are non-significant (p’s > .15). Significant interactions between the manipulation and Perceived Ability are represented with “Lo” (Low Perceived Ability) and “Hi” (High Perceived Ability).

Figure 12. Interactive effects of the relevance manipulation and Perceived Ability on Study 3 outcomes. 12A = Perceived Utility Value. 12B = Involvement. 12C. Identification.

Figure 13. Exploratory path model analyses on sub-sample of students in Study 3. Solid paths are standardized regression coefficients significant a $p < .05$. Non-significant paths have been omitted. Values in parentheses represent the effect after Involvement and Identification have been entered.

Figure 1

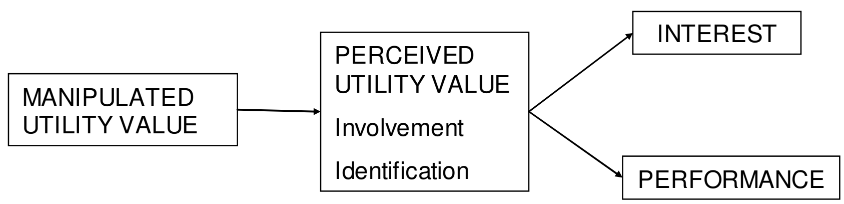

MANIPULATED UTILITY VALUE
PERCEIVED UTILITY VALUE
Involvement
Identification
INTEREST
PERFORMANCE

Figure 2

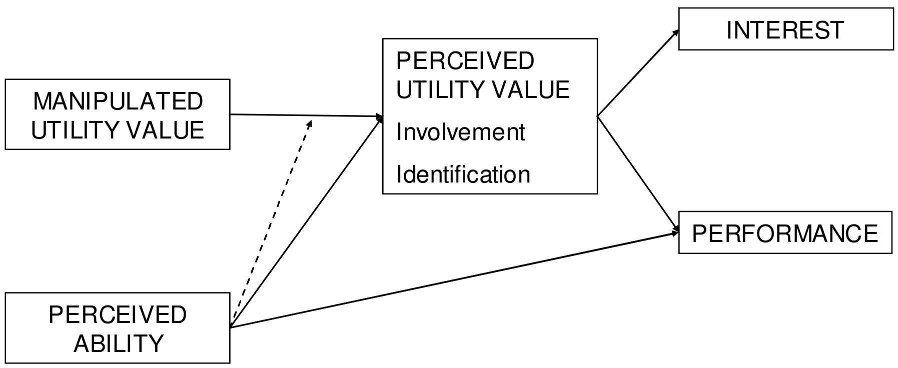

MANIPULATED
UTILITY VALUE
PERCEIVED
ABILITY
PERCEIVED
UTILITY VALUE
Involvement
Identification
INTEREST
PERFORMANCE

Figure 3A

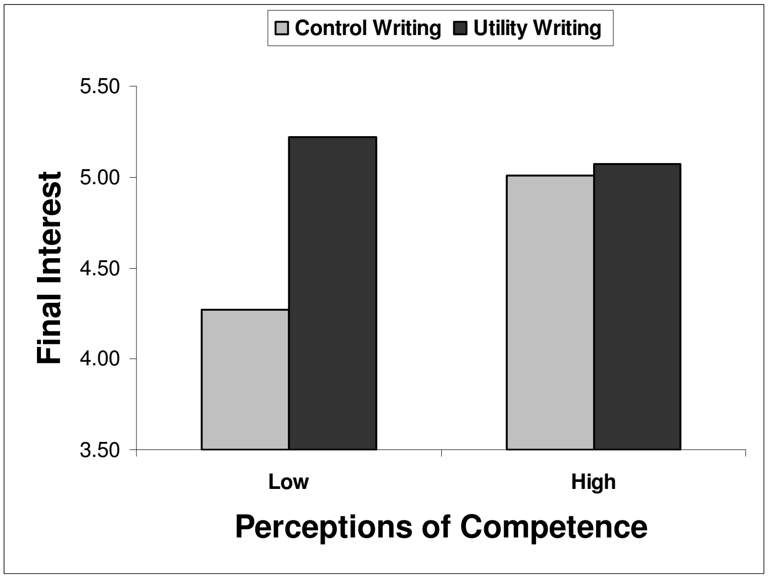


Figure 3B

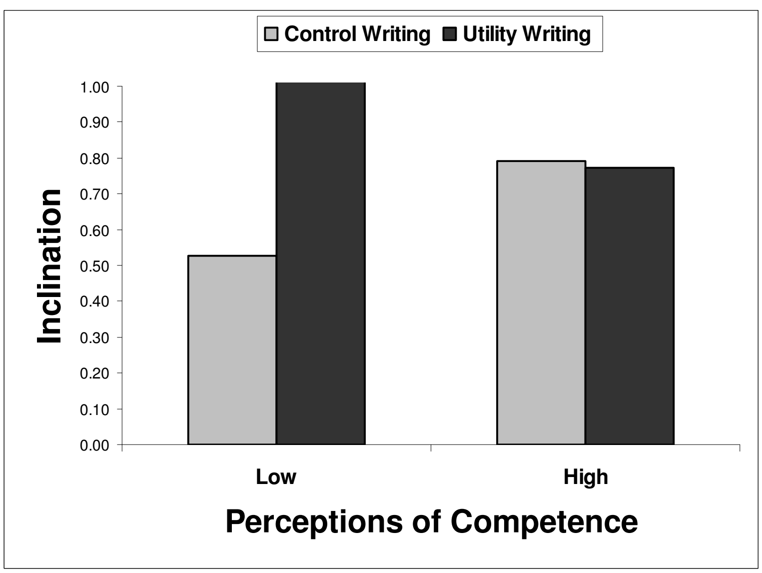


Figure 3C

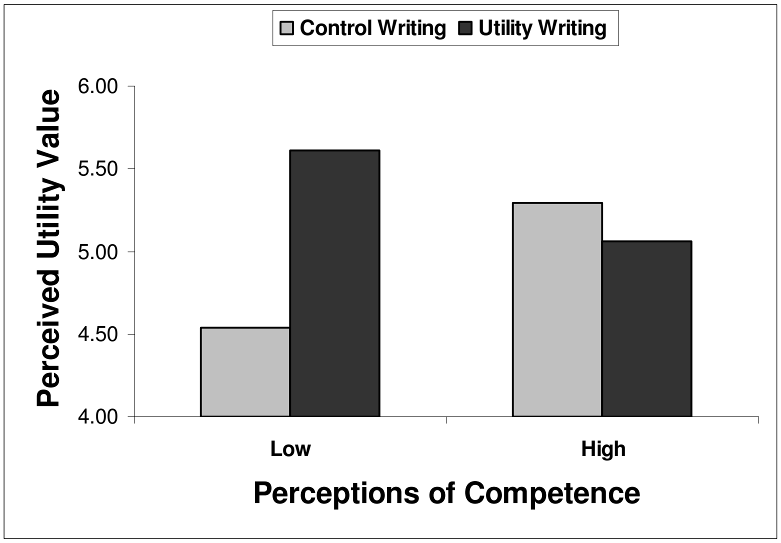

Control Writing
Utility Writing
6.00
5.50
5.00
4.50
4.00
Perceived Utility Value
Low
High
Perceptions of Competence

Figure 4

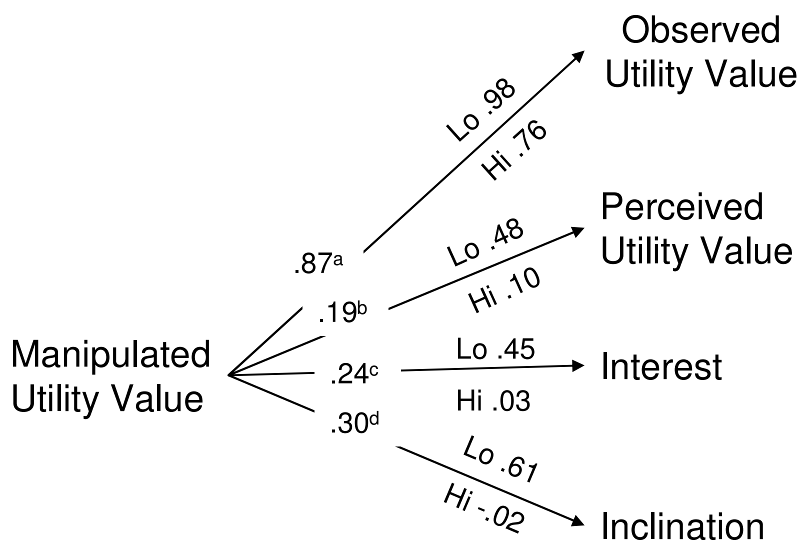

Observed
Utility Value
Lo .98
Hi .76
Perceived
Utility Value
Lo .48
Hi .10
.87a
.19b
Manipulated
Utility Value
.24c
Lo .45
Interest
Hi .03
.30d
Lo .61
Hi -.02
Inclination

Figure 5

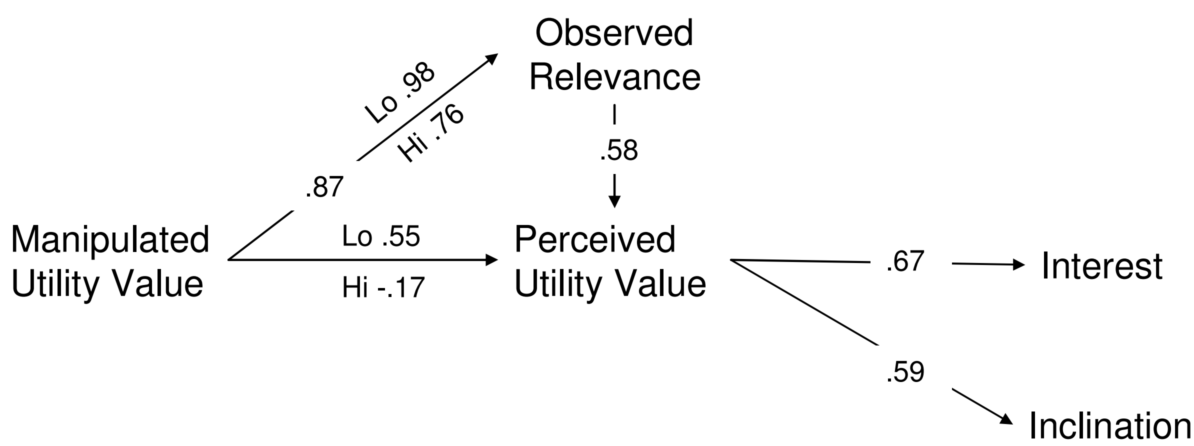

Observed
Relevance
Lo .98
Hi .76
.87
.58
Manipulated
Utility Value
Lo .55
Hi -.17
Perceived
Utility Value
.67
Interest
.59
Inclination

Figure 6A

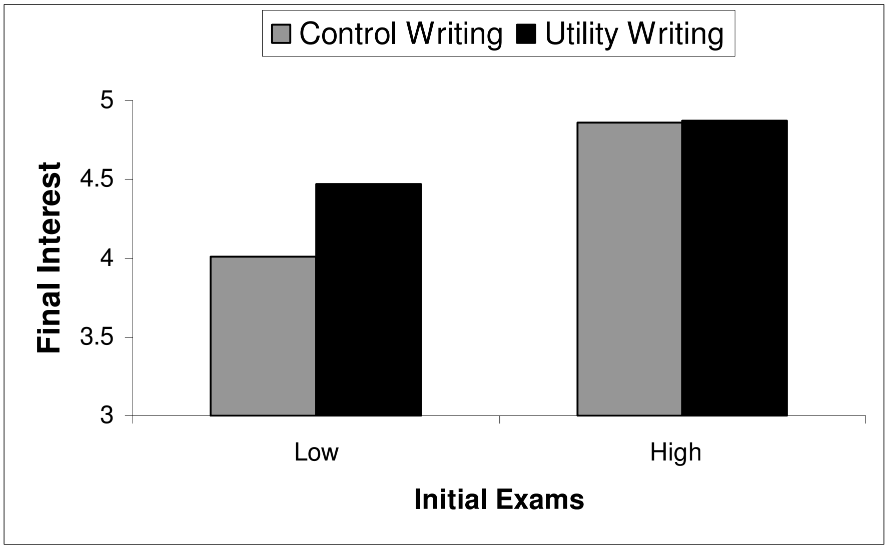


Figure 6B

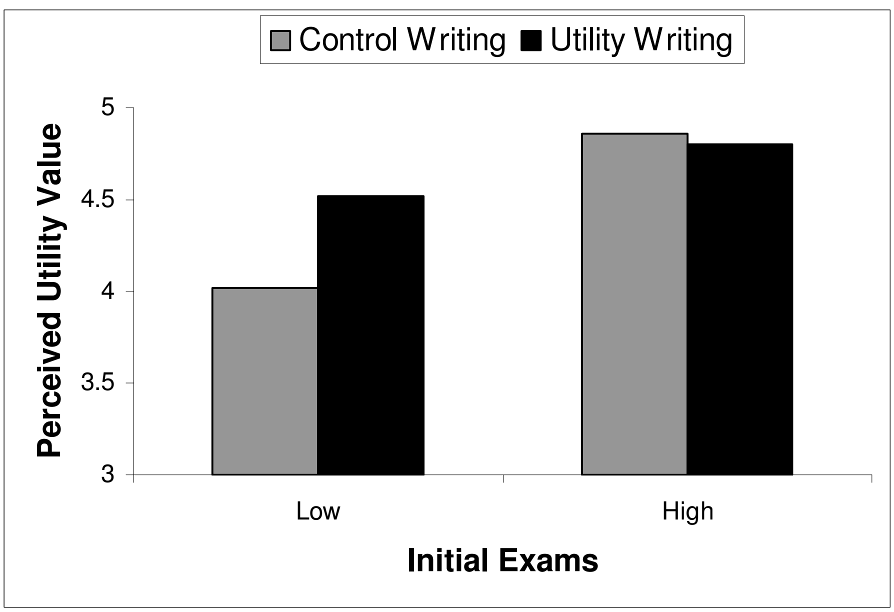


Figure 7

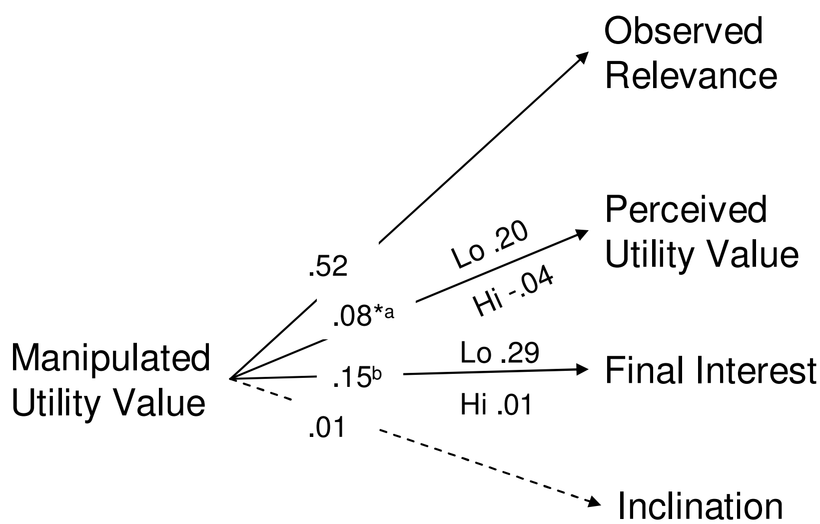

Observed
Relevance
Perceived
Utility Value
Final Interest
Inclination
Manipulated
Utility Value
.52
.08*a
.15b
.01
Lo .20
Hi -.04
Lo .29
Hi .01

Figure 8

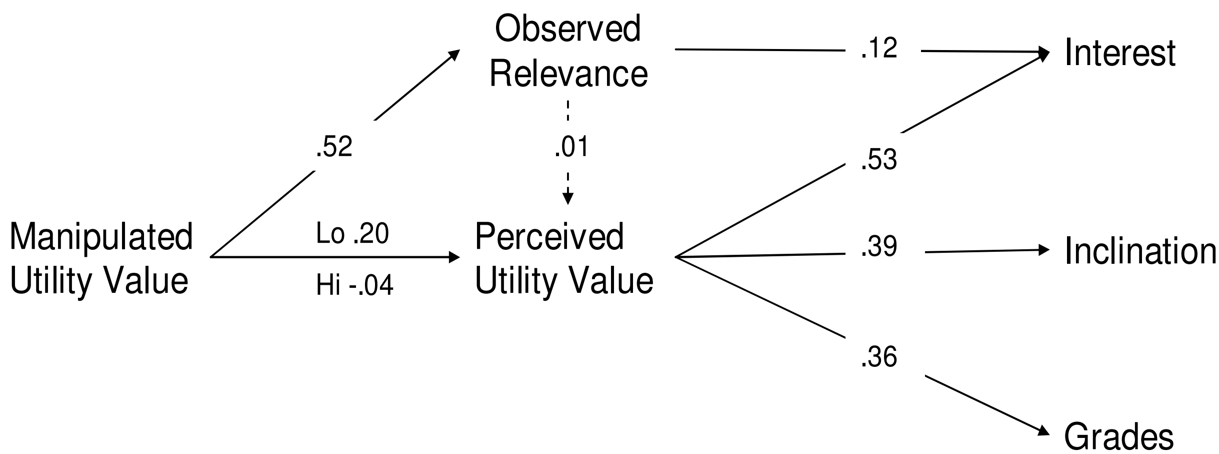

Observed Relevance
Manipulated Utility Value
Perceived Utility Value
Interest
Inclination
Grades
.52
.01
Lo .20
Hi -.04
.12
.53
.39
.36

Figure 9

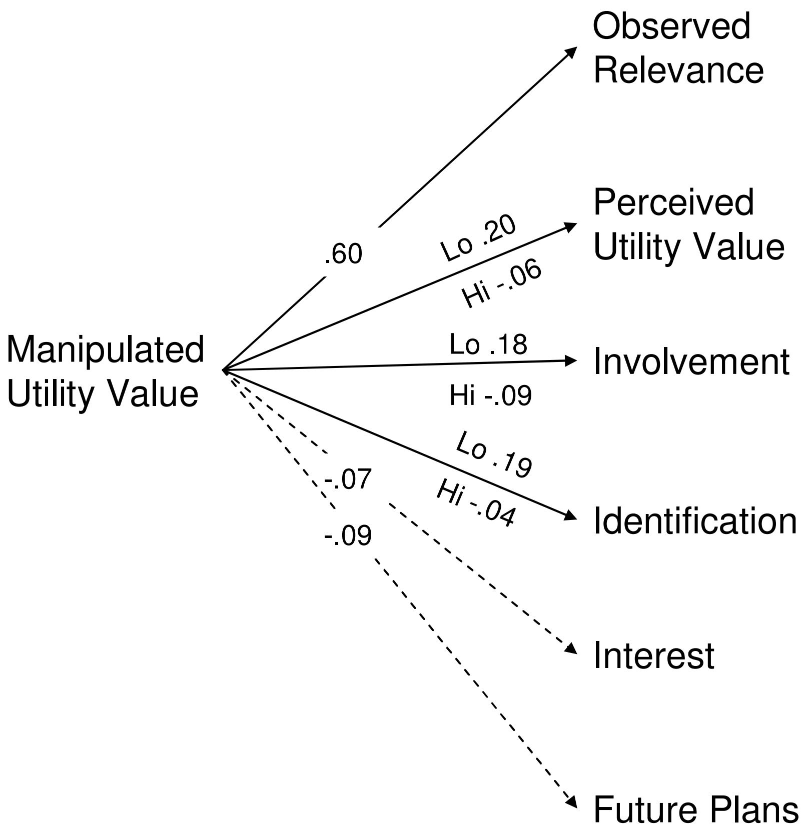

Observed Relevance
Perceived Utility Value
Involvement
Identification
Interest
Future Plans
Manipulated Utility Value
.60
Lo .20
Hi -.06
Lo .18
Hi -.09
Lo .19
Hi -.04
-.07
-.09

Figure 10

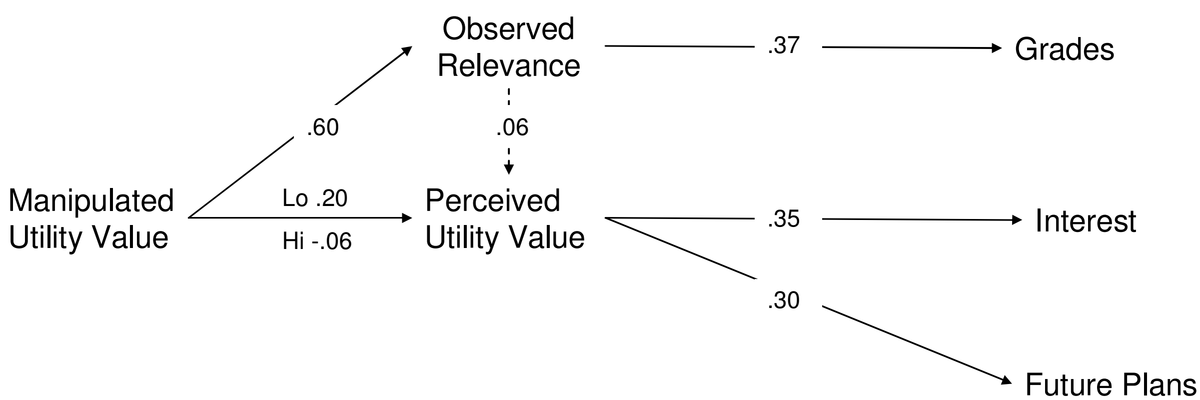

Observed
Relevance
.37
Grades
.60
.06
Manipulated
Utility Value
Lo .20
Hi -.06
Perceived
Utility Value
.35
Interest
.30
Future Plans

Figure 11

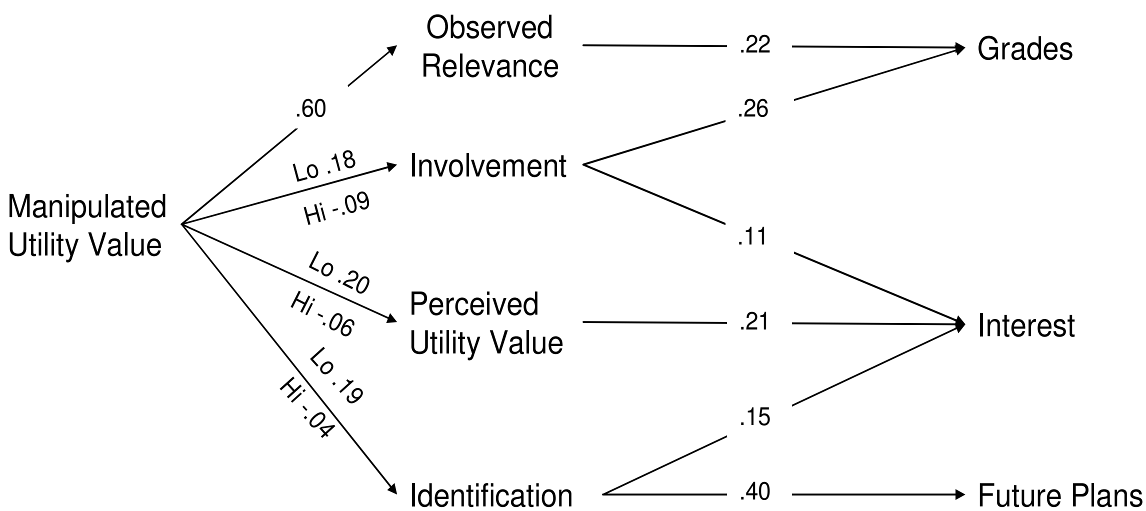

Manipulated
Utility Value
.60
Lo .18
Hi -.09
Lo .20
Hi -.06
Lo .19
Hi -.04
Observed
Relevance
Involvement
Perceived
Utility Value
Identification
.22
.26
.11
.21
.15
.40
Grades
Interest
Future Plans

Figure 12A

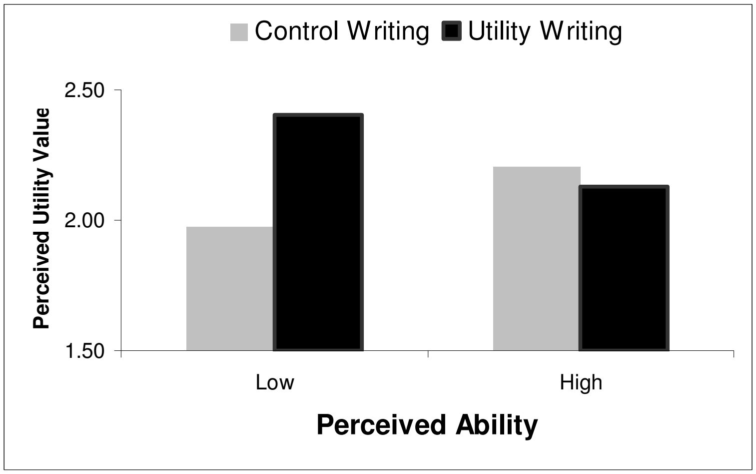


Figure 12B

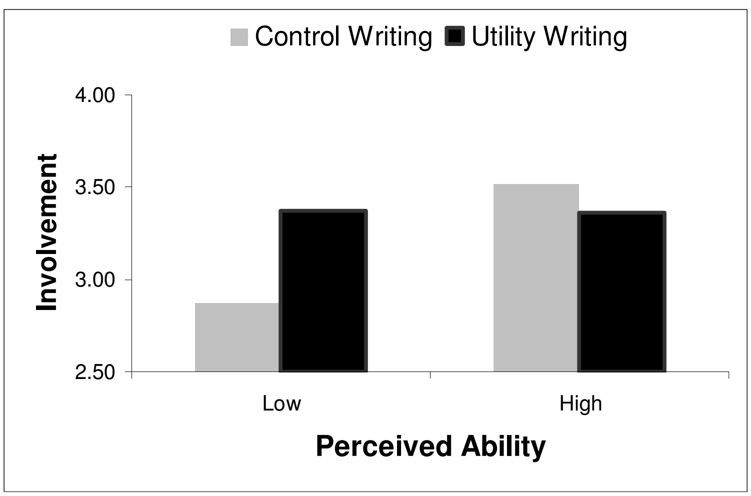


Figure 12C

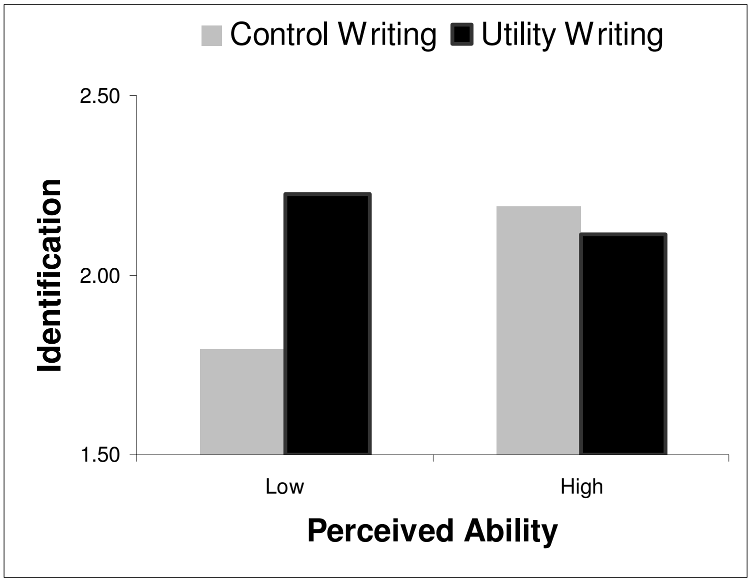
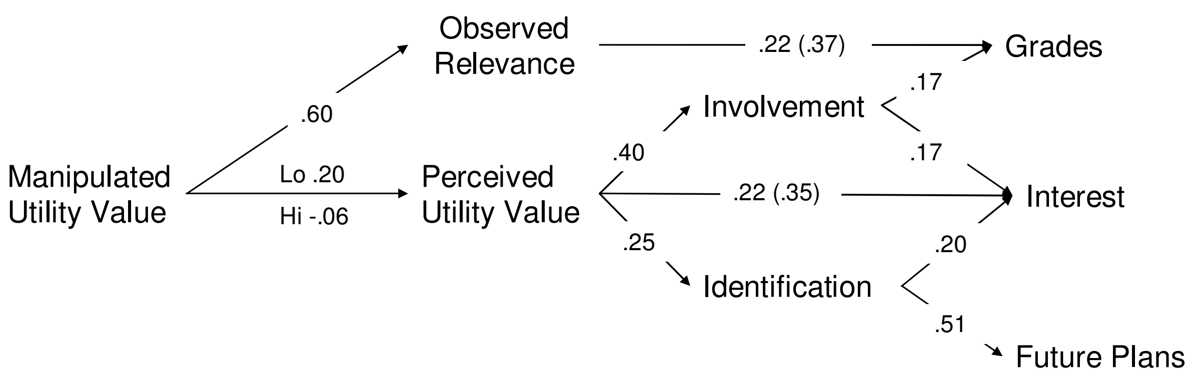

Control Writing
Utility Writing
2.50
2.00
1.50
Identification
Low
High
Perceived Ability

Figure 13


Observed
Relevance
.22 (.37)
Grades
.60
Involvement
.17
.40
.17
Manipulated
Utility Value
Lo .20
Hi -.06
Perceived
Utility Value
.22 (.35)
Interest
.25
.20
Identification
.51
Future Plans