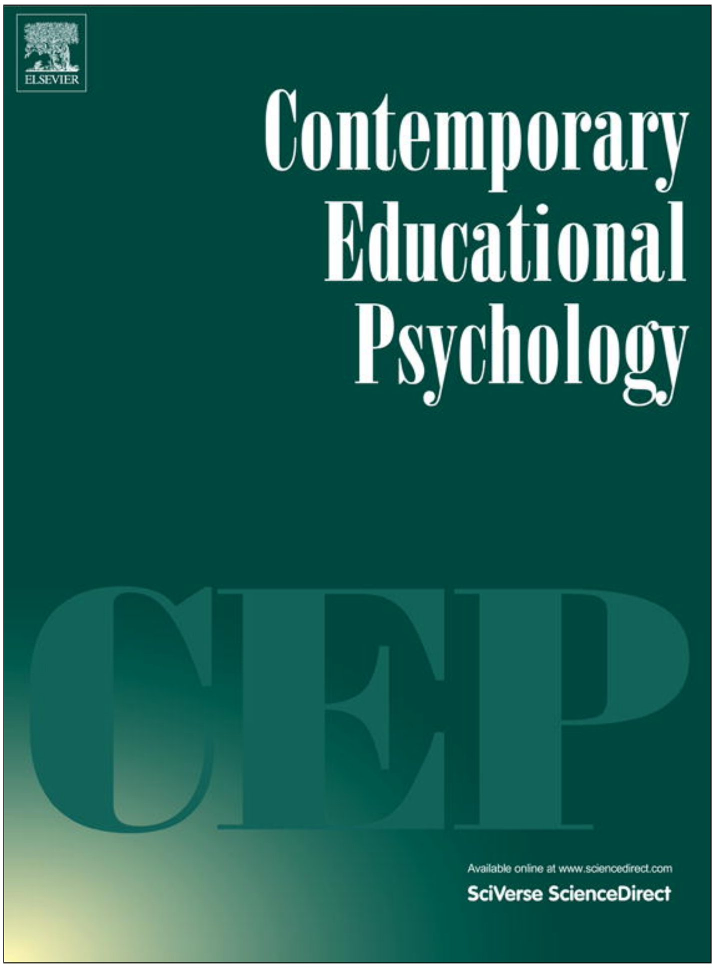

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Use of task-value instructional inductions for facilitating engagement and conceptual change

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ABSTRACT

This study explored the relationship between task values, engagement, and conceptual change. One hundred and sixty-six under graduate students were randomly assigned to one of three task value instructional inductions (utility, attainment, and control) to determine whether induced task values would result in different degrees of engagement and conceptual change when reading a refutation text about the common cold. It was hypothesized that the participants in the utility, attainment, and control conditions would differ in their engagement, and degree of conceptual change.

Statistical differences were observed among the participants in the task value and control conditions on perceived engagement as well as conceptual change. The results indicate that the participants who were in the utility condition rated their engagement as significantly higher than those in the control condition. Furthermore, participants in the utility condition demonstrated the greatest degree of conceptual change. The usefulness of task value inductions for facilitating engagement and conceptual change is discussed.

1. Introduction

Conceptual change has many definitions and descriptions (for multiple perspectives see the *International Handbook of Conceptual Change*, Vosniadou, 2008). These include developmental milestones that fundamentally alter the way cognition occurs (Wellman & Gelman, 1998), and spontaneous changes that are a result of increasing experience in interactions with objects and others in their environment (Hatano & Inagaki, 2003). For our purposes, we are interested in "instruction-induced conceptual change" (Inagaki & Hatano, 2008, p. 242) or what Vosnidou has described as "the kinds of conceptual changes that takes place when students are exposed to counter-intuitive concepts in science" (Vosniadou, 2008, p. 4). Instruction-induced conceptual change involves overcoming misconceptions, where misconceptions are characterized as ideas from students' everyday experience that conflict with scientific ideas.

Historically, conceptual change scholars had proposed that conceptual change was a rational process, and therefore they did not account for motivational and affective learner characteristics that impacted the change process. Early theories of conceptual change are therefore referred to as "cold" because they lacked descriptive accounts of what have traditionally been called "hot constructs" (i.e. emotion and motivation). In contemporary models of conceptual change, motivational factors have become more central to the conceptual change process (see Sinatra, 2005). In models like Dole and Sinatra's (1998) Cognitive Reconstruction of Knowledge Model (CRKM), motivation is assumed to instigate and sustain the cognitive engagement necessary to promote strong conceptual change. Engagement, defined as a learner's motivated interaction with a task, affords a learner with opportunities to make meaningful connections and deeply process information that can be used to restructure existing conceptions (Mason, Gava, & Boldrin, 2008).

However, what motivates learners to engage in a task will differ from individual to individual. Learners might be motivated to engage in a task and deeply process information because it is useful to their career pursuits, while others might be motivated to maintain a positive self-image (i.e. "getting an 'A' confirms that I'm a good student"). In these scenarios, learners can be described as motivated to take actions that would support their educational intentions. However, based on prior research, learners would be expected to engage in the learning task to differing degrees because of their varying motives (i.e. engaging in a learning task to better oneself for the workplace versus engaging in a learning task to confirm that one is an excellent student).

In studies like those of Cole, Bergin, and Whittaker (2008), task values, or motivated reasons for engaging in a task, have been found to be associated with differing degrees of effort in varying academic contexts. Specifically, the task values of utility (defined as finding a task useful) and attainment values (defined as finding a task important to confirming salient aspects of one's self-schema)

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were found to be strong predictors of effort and subsequently achievement in a variety of academic contexts. An intrinsic value (defined as finding a task interesting) was not as powerful of a predictor of effort. For achievement related tasks that stress students' performance, an attainment value may be predictive of achievement because it may focus students on their task performance as a whole. Utility values on the other hand, focus students' interaction on those aspects of the task that are perceived as useful; and an intrinsic value focus a student on aspects of the task that are interesting to them but may or may not have direct relevance to performing well on the task itself.

Greene et al. (2004) reported that perceived instrumentality, which can be thought of as an integrated conception of utility and attainment values, was predictive of deep cognitive engagement, students' use of higher-order learning strategies (i.e. elaboration); and subsequent achievement. Taken together, the Greene et al. and Cole et al. (2008) studies lead us to hypothesize that task values may differentially predict how a learner interacts [engages] with a learning task. Nonetheless, little is known about the influence of task values on conceptual change, and/or which task value might best enhance the cognitive engagement necessary to promote conceptual change, if any. Below, we present a brief review of conceptual change models and how they have developed into "hotter" models that include motivational factors. We also describe how conceptual change models may benefit from specifying the motivational factors that best enhance engagement and conceptual change. We then discuss how inducing individuals with differing task values may result in differing degrees of engagement, as well as differing degrees of conceptual change. Next, we report the results of a study comparing engagement and conceptual change outcomes in groups induced with different task values, which we believe contributes to the theoretical literatures on motivational instructional interventions, task values, and motivated conceptual change.

2. Conceptual change

Conceptual change research has primarily been concerned with investigating the structure of conceptions, how naïve or non-scientific conceptions develop, and the processes involved in restructuring non-scientific conceptions. Acknowledging that learners do not enter the classroom as blank slates, but often have existing conceptions about many scientific matters (Strike & Posner, 1992), Posner and his colleagues suggested that learning is a rational activity and that students make judgments on the basis of evidence. Posner, Strike, Hewson, and Gertzog (1982) proposed four conditions for which conceptual change can be facilitated. These conditions include becoming aware of the inadequacies in existing conceptions (dissatisfaction), appreciating how the scientific concept works (intelligible), perceiving the new concept to be a reasonable explanation of the phenomena (plausible), and applying the new concept to other areas of inquiry (fruitful).

A decade after Posner et al. (1982) proposed their theory of conceptual change, Strike and Posner (1992) acknowledged that their previous work was overly rational and did not account for "hot" constructs (i.e. emotions and motivation) that may influence the structure of learners' representations of concepts. Motivational and affective factors were set aside because Posner et al. noted that they intended to "focus [their] attention on what learning is, [and] not what learning depends on" (p. 212). It was not until Strike and Posner (1992) began to acknowledge the various aspects influencing a learner's conceptual ecology, that motivation and affective factors were reconsidered as integral components to the conceptual change process. Pintrich, Marx, and Boyle (1993) echoed Strike and Posner's claims that their early theory of conceptual change was overly rational (cold, mechanical, and without emotion), and that new models of conceptual change needed to become "hotter," accounting for constructs such as motivation and emotion. Since conceptual change involves overcoming a resistance to revise one's beliefs and adopt alternative beliefs, Pintrich et al. suggested that motivational constructs (goals, values, self-efficacy, and control beliefs) could influence the process of conceptual change.

Warming trend. Following Pintrich, Marx, et al.'s (1993) call for conceptual change theories to take motivation and affect into account, a "warming trend" occurred whereby conceptual change researchers integrated these constructs into their frameworks (Sinatra, 2005). Two influential models contributed to this warming trend: Dole and Sinatra's (1998) Cognitive Reconstruction of Knowledge Model (CRKM) and Gregoire's (2003) Cognitive–Affective Model of Conceptual Change (CAMCC). In Dole and Sinatra's CRKM (1998), characteristics of the learner (which includes a learner's motivation) interact with characteristics of a message to establish the degree to which the learner engages with the new concept. It is the degree of engagement, how deeply one interacts with the learned content, which ultimately determines the degree of change one experiences. In a similar fashion, Gregoire's CAMCC (2003) suggests that motivational constructs may influence how individuals process or engage with a new concept, thereby contributing to the degree to which one undergoes change.

Though these models of conceptual change suggest that hot constructs such as motivation can be incorporated into conceptual change theories, hypotheses about how the impact of specific motivational constructs such as task values cannot be directly generated from these models. This is because "hot" conceptual change models take into account motivation in more general terms and do not suggest specific hypotheses for task values. Therefore, we examined research on motivation and conceptual change to guide our investigation.

Linnenbrink and Pintrich (2002) investigated the role of achievement goals in conceptual change in physics learning. They hypothesized that students who adopted mastery goals would result in greater conceptual change because mastery goals are associated with adaptive learning strategies that help students focus on learning the material. Conversely, they hypothesized that students who adopted performance goals would demonstrate little or no conceptual change because performance goals are related to shallow learning strategy use and may distract students' focus away from a learning task. Linnenbrink and Pintrich found some support for their hypotheses, in that performance goals were unrelated to conceptual change; and mastery goals related to conceptual changefor those with low prior knowledge.

3. Expectancy-value theory

The utility of previous studies on motivational constructs and conceptual change is somewhat limited for the present study because the theoretical framework of expectancy-value theory (EVT) has, to our knowledge, yet to be explored in conceptual change research. EVT relies on the basic premise that individuals are motivated by their reasons for engaging in a task and their expectations for success. Expectancy can be conceived as individuals' belief in the probability of their success on a learning task.[1] The

[1] Contemporary models of EVT identify two distinct types of expectancies, outcome expectations and efficacy expectations (Wigfield & Eccles, 2000). Outcome expectations refer to one's belief that a certain action will produce a certain outcome, and efficacy expectations refer to one's belief that they can produce a particular behavior (Eccles & Wigfield, 2002). Although efficacy expectations have been found to be a strong motivational predictor of many adaptive achievement and learning outcomes, the focus of this study was on the inducing learners with specific task-values. An instructional induction for efficacy expectations was beyond the scope of this study.

value component of EVT refers to task values, or reasons individuals have for engaging in a task. Eccles and Wigfield (2002) describe four types of task values: utility value, attainment value, intrinsic value, and cost. Utility value refers to the belief that a task is applicable or instrumental to one's future goals (i.e. I want to take a course in calculus because I believe I will utilize calculus in my future career as an engineer). Attainment value refers to the degree of importance an individual places on a task for confirming or refuting salient aspects of one's self-schema (i.e. I want to get a good grade in my math class because I believe my grade is a reflection of my ability as a student). Intrinsic value can be defined as the enjoyment or interest one has in a task (i.e. I want to take a course in calculus because I enjoy working with numbers). Finally, the task value of cost can be defined as the expense or negative consequences for engaging in a task (i.e. I attend my calculus courses because I have already paid my tuition; and it would be a waste of my money if I do not attend).

Although Cole et al. (2008) had demonstrated that both utility and attainment values were more adaptive in various academic achievement contexts over intrinsic values, specific hypotheses about which task value is most adaptive for learning are lacking from the literature concerning EVT. One possible reason why specific hypotheses are difficult to generate may be due to the challenge of isolating and operationalizing task values. Wigfield and Eccles (2000) acknowledge that there may exist some overlapping elements among the task values they described. Greene et al. (2004) defined their psychological construct of perceived instrumentality as capturing aspects of both utility and attainment values. They argued that perceiving a task to be instrumental and useful (utility value) assumes that a person recognizes the importance of the task in relation to their self-schema (attainment value). Despite the possible overlapping elements for task values, Wigfield and Eccles (2000) stress that utility, attainment, and intrinsic values emerged from different theoretical perspectives and can therefore be defined separately. Cole et al. (2008) suggested that future research that can manipulate the task value for a learning task would be useful and perhaps help support for their claims that attainment and utility values should be stressed in learning environments.

The various task values described within EVT may allow students to make meaningful connections with new conceptions by instigating and sustaining the cognitive engagement necessary to facilitate conceptual change (Dole & Sinatra, 1998). However, different task values may lead students to lend their attention to different aspects of a task's content, and lead students to engage different with that content. This is because the task values provide different means by which the new conceptions can be conceptually connected to students' values for the task (i.e. utility to future career goals or enhanced self-schema). A learner with a high utility value may focus on content that has practical meaning or can be applied in a useful way; whereas a learner with a high attainment value may only make meaningful connections to aspects of the content that confirm and/or refute salient aspects of their self-schema.

4. Motivation, cognitive engagement, and conceptual change

Engagement can be conceived as the quality of one's interaction with a task, which can vary from shallow and superficial processing to motivated and strategic processing (Guthrie et al., 2004). According to Dole and Sinatra's (1998) CRKM, engagement is hypothesized to exist on a continuum from low to high, and the degree of engagement mediates the influence of motivation on conceptual change. Dole and Sinatra contend that individuals who fall on the high end of the engagement continuum are more likely to achieve strong conceptual change, as they should be more likely to make meaningful connections with their existing conceptions by utilizing deep processing strategies, elaborative strategies, and/or reflection.

Several studies involving the motivational construct of task value describe some motivational elements that may stimulate and sustain cognitive engagement on learning tasks (Cole et al., 2008; Greene et al., 2004; Miller, DeBacker, & Greene, 1999). For example, Greene et al. note that,

> A smaller, more recent body of research…has linked effective cognitive engagement to perceived instrumentality. The conceptual underpinnings of this relationship are as follows: as tasks increase in their perceived instrumentality, the incentive value of success also increases. Students invest greater effort and more appropriate cognitive resources to tasks perceived as having high personal incentive value. (p. 476)

In the study by Greene et al. (2004), a path analysis was used to test the impact of the motivational constructs (i.e. achievement goals, self-efficacy, and perceived instrumentality) on engagement (strategy use), and high school students' achievement. Greene et al. reported a positive indirect effect of perceived instrumentality on achievement mediated by engagement. The relationships expressed in this path model echo what Greene and her colleagues have found in their previous work (see also Greene & Miller, 1996; Miller, Greene, Montalvo, Ravindran, & Nichols, 1996; Miller et al., 1999). In all cases, the authors argue that perceived instrumentality should be fostered in educational settings as they are predictive of engagement, achievement, and/or mastery goals.

> If students do not perceive current academic activities as instrumental to attaining personally relevant future goals, we question whether those activities will have sufficient incentive value to foster the level of student cognitive engagement necessary to produce meaningful learning. (Miller et al., 1999, p. 258)

In a separate study involving three task values (intrinsic, attainment, and utility), Cole et al. (2008) tested path models of task values on college students' achievement on low stakes tests, when mediated by students' reported effort. Only attainment value and utility value significantly predicted students' effort and subsequently their achievement on the English, math, science, and social studies tests. In all four path models, utility value yielded the strongest positive direct effects on students' reported effort. To explain the lack of direct and indirect effects of intrinsic value on effort and achievement, Cole et al. stated "interest to do well on the exam without appropriate levels of importance to do well is not conducive to test performance" (p. 621). Cole et al. made similar instructional recommendations as those expressed in Miller et al. (1999), in that students' effort and/or engagement on a task may suffer if they do not perceive a task to be useful and/or important.

5. Present study

Relationships between engagement and conceptual change and between task value and engagement are relatively established in the literature. Additionally, the models hypothesizing engagement as a contributing variable in the relationship of motivation on conceptual change are also hypothesized in the conceptual change literature (Dole & Sinatra, 1998; Linnenbrink & Pintrich, 2002). What is missing from our understanding, however, is whether task values can be induced to promote conceptual change through enhanced engagement. Previous empirical studies have not investigated the role task values play in the conceptual change process. Conceptual change is difficult to bring about. If inducing a greater degree of motivated engagement can enhance conceptual change, this could be a simple and effective means of creating the conditions for motivated knowledge restructuring. The purpose of the present study is to investigate the role of task values in facilitating conceptual change by applying a motivational intervention designed to induce students with differing task values.

The conceptual topic chosen for the present study was causes the common cold. This topic was chosen because of the rich literature that documents the many misconceptions people have about the common cold, as well as the feasibility of tying task value instructional inductions to the topic for the study participants, pre-service teachers. Many educators who enter K-12 school settings will likely encounter school-aged children infected with the common cold, thus this topic provides the opportunity for an instructional induction for utility value that stresses the usefulness of information on the common cold for future teachers who might wish to minimize the spread of the common cold in their classrooms. As many educators invest years in their own higher education, an instructional induction that stresses how one's performance on an academic task could be a reflection of their academic abilities, may foster the adoption of an attainment value for this content which is consistent with health education courses they are required to take as part of the teacher education program.

6. Research questions and hypotheses

We investigated three research questions: (1) Would the participants in the utility, attainment, and control conditions differ in task values? We hypothesized that the participants in each condition would adopt characteristics that were consistent with the instructional induction they received; and therefore differences should be observed among the conditions on measures of task value (i.e. subscales for utility value and attainment value) and/or assessments pertaining to how participants approached the reading task.

(2) Would the participants in the utility, attainment, and control conditions differ in their engagement for the learning task? We hypothesized that statistical differences among the conditions would emerge based on Cole et al.'s (2008), findings that perceived utility was predictive of cognitive engagement. We expected that participants in the utility condition would experience the greatest level of engagement.

(3) Would the participants in the utility, attainment, and control conditions differ in their conceptual change? We hypothesized that the participants in the utility, attainment, and control conditions would statistically differ from one another. Specifically, we hypothesized that those in the utility condition would experience the greatest amount of conceptual change, since the CRKM predicts that individuals who deeply engage with a learning task will experience stronger conceptual change than those who fail to engage or weakly engage in a learning task.

7. Methods

7.1. Participants

Participants included165 undergraduate students (129 female, 33 male, and 3 not reported) from an Educational Psychology subject pool at a large public urban university in the southwest.[2] Approximately 82% of the participants designated themselves as education-related majors. Overall, this sample had a mean cumulative GPA of 3.14 and the age range of the participants was 18 to 59, with an average age of 24. In this sample, 37 participants identified themselves as seniors, 71 as juniors, 47 as sophomores, 4 as freshmen, and 6 unknown. The ethnic breakdown of this sample could be described as 61% Caucasian, 15% Hispanic/Latino, 8% Black/African–American, 11% Asian/Pacific Islander, 5% Other/Unknown. This breakdown was comparable to the population of students at the institution in which the participants were enrolled. The gender and ethnic distribution in the sample was typical of the overall population of education students at this institution. Despite the unequal gender distribution of this sample, no statistical differences were observed between males and females on pretest ($F(1,161) = .000$, $p = .999$, $\eta^2 = .0005$) or posttest ($F(1,161) = .54$, $p = .46$, $\eta^2 = .003$) scores for conceptual knowledge of the common cold.

7.2. Materials

Task value instructional inductions. For the purposes of this study, two instructional inductions that were specific to inducing participants with the task values of "utility value" and "attainment value" were developed. The rationale in developing inductions for utility value and attainment value stemmed from previous findings in which utility value and attainment value appeared to be more predictive of adaptive characteristics (i.e. effort and achievement) than alternative task values (i.e. intrinsic) (Cole et al., 2008) and thus seemed most likely to have the potential to facilitate conceptual change. An additional consideration was the feasibility of inducing learners with task values. Instructional inductions cost were not generated for this study because inducing a cost value raised ethical concerns about charging, or penalizing, participants. Inducing intrinsic interest seemed unlikely to succeed in a relatively short-term task.

Methods of inducing students with various motivational constructs have included the use of task instructions to prime and reinforce varying motivational behaviors/characteristics (see Hulleman, Godes, Hendricks, & Harackiewicz, 2010; Jang, 2008; Linnenbrink & Pintrich, 2002; Reeve, Jang, Hardre, & Omura, 2002; and Reitman, 1960). Linnenbrink and Pintrich's instructional inductions directed students to "try your best" (to elicit mastery goals), or "beat all of the other students" (to elicit performance goals). In Jang's study, rationales for engaging in a task were embedded into the task's instructions ("once learned, the correlations featured in today's lesson will open the door for you to gain useful skills, ones that will be very handy when you need to interpret information presented through statistical tools," Jang, 2008, p. 802). Jang claims that the provision of rationales adds to participants' identification with the task, and explains subsequent effort.

For the present study, the task value inductions were formatted in a manner consistent with the task instructions utilized by Jang (2008), as well as Hulleman et al. (2010) and Linnenbrink and Pintrich (2002). Participants were asked to read a brief story about a fictional student who behaved in accordance with a specific value (i.e. for attainment value "Jordan's goal is to demonstrate that he is a good student. Doing poorly in the course would be a bad reflection upon Jordan's academic abilities..."). Participants were then asked to reflect on whether they know of any students or colleagues who behaved in such a manner or share similar beliefs as Jordan. Additionally, participants were asked to reflect on times in which they behaved in a similar manner or shared similar beliefs as Jordan. Participants were provided instructions to approach the reading task in accordance with the task value being induced (i.e. for utility value induction: "While you are reading the passage, consider how the information can be applied to future situations. Approach the reading task like Jordan. I will be interested to see if, for the remainder of this survey, you can find the information useful for your future career pursuits") (for the complete induction instructions see Appendix C). Finally, participants in the utility or

[2] An outlier in the control condition was excluded due for exceeding an absolute value of a z-score of 3 on conceptual understanding about the causes of the common cold. This individual also had an incomplete data set.

attainment induced groups were asked to describe any additional ways in which the materials could be relevant to their careers or a reflection of their academic abilities respectively (consistent with Hulleman et al.'s instructions). Instructions for the control group were free of statements that reflect those of the task value inductions, and simply informed participants that "on the next page I will be giving you a reading about the causes of the common cold."

Task value. The Motivated Strategies for Learning Questionnaire (MSLQ) is a well-established measure of motivational constructs, as well as cognitive learning strategy use (Pintrich, Smith, Garcia, & McKeachie, 1993). The entire MSLQ consists of 81 (7-point Likert-scale) items, 31 of which are reserved for assessing students' academic motivation characteristics. For the purposes of this study, the task value subscale of the MSLQ (six items) was utilized to assess students' perceived task values both before and after the intervention. These items were further categorized into their respective task values, as described by Eccles and Wigfield (2002). Two items were categorized as utility value items, because they are phrased in a manner that suggests that a task is useful and/or applicable to obtaining future goals (i.e. "I think I will be able to use what I learn in this course in other courses"). Two items were categorized as attainment value items, because they simply specified that the task is important to the individual (i.e. "Understanding the subject matter in this course is very important to me").

This categorization of the MSLQ task value subscale is somewhat atypical since the subscale is often just summed for an overall task value score. Husman, Pitt Derryberry, Michael Crowson, and Lomax (2004) report using only four of the six task value items as a general measure of task value after their item analysis indicated that two items could be eliminated. Concerned that the use of the MSLQ items for task value may be limited in strictly assessing utility and attainment values, we developed four additional items for both utility and attainment value,with the intention of obtaining robust reliability scores. Utility and attainment value items were scored separately and employed as a pre- and posttest measure. With a total of six items for perceived utility and six items for attainment value (see Appendix D), pretest and posttest Cronbach alpha reliability coefficients ranging from .87 to .94 were obtained.

Engagement measure. We used a modified version of the Approaches to Learning Survey subscale for cognitive engagement (DeBacker & Crowson, 2006; Greene & Miller, 1996; Greene et al., 2004; Miller et al., 1996). In total, we modified 11 items for deep cognitive engagement and five items for shallow cognitive engagement[3] in a manner that was consistent with the learning task for this study (the reading text). For example, an item for deep cognitive engagement, "when I read for this exam I stopped to ask myself whether or not I am understanding the material," was modified for this study to read, "when I read for the previous text, I stopped to ask myself whether or not I am understanding the material."

Greene and Miller (1996) reported reliability coefficients (Cronbach's alphas) of .90 and .81 for their three deep cognitive engagement items and three shallow cognitive engagement items respectively. After appropriate modifications and additions were made to the items for deep cognitive engagement in this study, Cronbach alpha coefficients of .84 and .89 were obtained for the deep and shallow cognitive engagement items respectively. Engagement was determined by summing participants' responses to items of deep cognitive engagement.

Refutation text on causes of the common cold. The text for this study was a 985 word refutation text on the causes of the common cold. Refutation texts, which state common misconceptions, and then directly refute them, have proven to be effective in promoting conceptual change in prior research (Author, 2011; Guzzetti, Synder, Glass, & Gamas, 1993). As previously noted, the topic was selected because conceptual knowledge about the common cold has relevance to our participant population, prospective teachers. Teachers are often confronted with students who are ill and thus our participants may be interested in learning how they can prevent the spread of colds in their future classrooms. In addition, many people have a number of misconceptions regarding the common cold, which also makes this topic appropriate for a conceptual change intervention. For example, many people believe that exposure to cold weather and/or not wearing warm clothing in cold weather are causes of the common cold, or other upper-respiratory infections (Johnson & Eccles, 2005; Larson, Ferng, McLoughlin, Wang, & Morse, 2009). However, a more appropriate conception would involve an individual understanding that as temperatures outside get cooler, people are more likely to spend time indoors and in close proximity to others who may be infected with the contagious rhinovirus. Other common misconceptions that have been expressed about the causes of the common cold include the belief that bacteria, germs, and viruses are all causes of the common cold, and the terms themselves can be used interchangeably (Gillen & Mayor, 1995). Another misconception involves the notion that antibiotics can be used to treat colds (see Lee, Friedman, Ross-Degnan, Hibberd, & Goldmann, 2003, for more on misconceptions pertaining to the "common cold"). These misconceptions may stem from application of the incorrect mental model of a weakened immune system or bacterial infectious disease as the cause of the common cold, which instead is caused by a virus. Alternatively, miscategorizationof the common cold to a category other than virusmay require a type of conceptual change that requires an ontological shift (Chi, 2008).

Text content was drawn from sources that described results and conclusions of published research studies that refute the common misconceptions about the causes of the common cold as well as provide information about effective methods for reducing the spread of the common cold (see Journal of Environmental Health, 2006; Pittet & Boyce, 2003; Turner & Hendley, 2005; Roberts et al., 2000). For example, to refute the notion that bacteria can be a cause of the common cold, the following refutational statement was included in the text, "Some people believe that bacteria cause the common cold. But, actually, it is viruses, and viruses alone that cause the common cold." The text had a total of 4 refutational statements and a readability score (Flesch Kincaid Grade Level) of 13.9, which is at the level of the targeted sample.

Conceptual knowledge assessment. Items were generated from the text's content to construct a measure of conceptual understandings of the causes of the common cold. A 16-item measure (consisting of 10 true/false, and 6 multiple-choice items) was administered to all participants pre- and posttest. Items were scored for their correctness (1 point per correct response) and summed for a possible total of 16 points. Pilot studies revealed that more than 60% of the participants in the targeted sample shared common cold misconceptions that stem from the incorrect mental model that the cold could be caused by a bacterial infection or mistaken belief that that it overcomes a weakened immune system. These misconceptions include the notions that the common cold can be caused by bacteria, that antibiotics can be used to treat the common cold, and exposure to cold weather can activate the common cold causing agent, all points targeted by the conceptual knowledge assessment. The results of the pilot studies suggested that not only are misconceptions about the common cold prevalent, but that an appropriate scientific understanding of what

[3] Miller et al.'s (1996) subscale scale for deep and shallow [engagement] strategy use consisted of six items and five items respectively. DeBacker and Crowson (2006) report using a version of the Approaches to Learning Survey that had six items for deep [meaningful] cognitive engagement and four items for shallow cognitive engagement, compared to Greene and Miller (1996) who utilized three items for both deep and shallow cognitive engagement.

causes the common cold has a conceptual structure. Thus, the conceptual knowledge assessment for this study targeted conceptual understandings of the common cold as a virus, its progression, and preventative measures that can be taken to minimize its spread. Difference scores (posttest–pretest) on this measure were used as our conceptual change variable because we were interested in comparing the induction groups on the amount of change they experienced, and not just their end achievement.

Confirmation questions. In addition to the aforementioned materials, we developed a set of confirmation questions, as fidelity checks, to ascertain the effectiveness of the task value inductions and to ascertain students' perceived engagement and conceptual change. The purpose of generating confirmation question stems from the difficulty that Linnenbrink and Pintrich (2002) expressed in observing differences between their goal induced conditions on self-reported goal orientations. Though they could only report a statistical difference in performance goal orientation by condition, Linnenbrink and Pintrich expressed little confidence in the effectiveness of their instructional inductions, and decided to dismiss their grouping variable in favor of self-reported goals for their later analyses regarding conceptual change. Arguably, goal orientations are stable and perhaps difficult to alter in a one-time activity. It is unclear whether inducing task values would be just as difficult. Concerned that the self-report subscales for task value modified from the MSLQ may not be sensitive enough to pick up on differences in perceived task value and thereby not allow us to determine the effectiveness of our instructional inductions, quantitative and qualitative confirmation items were developed so that participants' responses could be triangulated.

Participants were asked to respond to five confirmation questions using 7-point Likert scale, in which the first three of these items asked participants whether they tried to relate the reading content to issues useful to their career (utility value); strived to do well on the reading due to the importance of the information (attainment value); or just to get through the reading. Two items asked participants to rate the degree to which they felt engaged in the reading and the degree of conceptual change students perceived they experienced. The item concerning engagement in the reading task was created as a possible alternative variable to the modified Approaches to Learning Survey (Greene & Miller, 1996) we used. Whereas Greene and Miller's subscale for deep cognitive engagement (i.e. elaboration, planning, summarizing, etc.) is reliable in predicting academic achievement, we felt that an explicit item that asks learners whether they were engaged more specifically in our reading task could potentially be a more direct indicator of engagement in the task (as opposed to strategy use).

In addition to the five Likert-scale items, participants responded to an open-ended confirmation question. They were asked to describe in their own words their "...overall goal for the previous reading task." This item was meant to elicit participants' goals for the task, not their general achievement goal orientation. Responses were coded as utility oriented if participants referenced the usefulness of the information to future situations; attainment oriented if participants referenced the importance of doing well on the assessments; or neutral if participants simply responded, "to learn more about the causes of the common cold." Coders were blinded from knowledge of participant condition.

Procedures. Participants were recruited through an online subject pool system. They received 1 h of research credit awarded in partial fulfillment of course research requirements. The announcement for this study indicated that participants would be asked to read about a science topic. Participants were informed that the reading would specifically be about causes of the common cold at the time of consent. In accordance with the procedures approved by an institutional review board (IRB), after consenting to participate, participants were provided a link that randomly launched one of three versions of the electronic materials for each condition (utility value, attainment value, or control condition). Participants were then directed to the pretest page where they completed the perceived task value items (derived from the MSLQ) and the conceptual understanding assessment about the causes of the common cold. Upon completion of the pretest, participants received one of three instructional inductions (utility value, attainment value, or control condition [no inducing of a value]). After the instructional inductions, all participants, regardless of the instructional induction conditions were directed to the reading task on the causes of the common cold. Following the reading, students were directed to complete the posttest of conceptual understandings of the causes of the common cold, the measure of cognitive engagement, the posttest of perceived task value, confirmation questions, and demographics. In total, the average time for completion of the tasks was just under 1 h. The data was electronically downloaded and converted into a format suitable for analysis by a statistical software program.

8. Results

Preliminary analyses. Of the 165 participants included in our data analysis, 54 participants (42 female, 10 male, 2 unknown) were randomly assigned to the utility condition, 54 participants (42 female, 12 male) were randomly assigned to the attainment condition, and 57 (45 female, 11 male, 1 unknown) were randomly assigned to the control condition. In response to a 1–7 Likert-scale item about the level of knowledge participants had about the common cold prior to the reading task in this study, participants expressed being somewhat knowledgeable about what causes the common cold ($M = 4.1$, $SD = 1.2$). Pretest scores for the sample however, suggest that participants had limited conceptual understandings about what causes the common cold with the average pretest score of 7.7 ($SD = 3.2$) out of 16 or less than 44% correct. More than half of the sample responded with misconceptions such as bacteria are the leading cause of the common cold. Even through participants were randomly assigned to task value induction conditions, statistical differences were observed between our conditions on their pretest scores of conceptual knowledge, $F(2,162) = 6.1$, $p = .003$, $\eta^2 = .07$ [with a medium effect size], where Tukey post hoc comparisons indicate that the utility condition ($M = 6.54$, $SD = 2.86$) had significantly lower pretest scores than both the attainment ($M = 8.55$, $SD = 3.54$) and control ($M = 7.96$, $SD = 2.86$) conditions; the attainment and control conditions did not significantly differ from one another. Due to these differences, pretest scores are used as a covariate in later analyses. In a one-way analysis of variance (ANOVA) where the conditions are compared on their posttest knowledge scores, statistical differences are again observed, $F(2,162) = 6.28$, $p = .002$, $\eta^2 = .07$ [with a medium effect size], however this time the control condition ($M = 10.47$, $SD = 3.71$) yielded the lowest average in comparison to the utility ($M = 12.28$, $SD = 3.14$) and attainment ($M = 12.54$, $SD = 3.07$) conditions; the utility and attainment conditions did not statistically differ from one another. Table 1 provides the means and standard deviations for the measures of interest.

Correlation matrix. Table 2 presents a correlation matrix of the variables of interest. Deep cognitive engagement as measured by the Approaches to Learning Survey subscale adopted from Greene and Miller (1996), was significantly correlated with participants' posttest scores for conceptual understandings about the causes of the common cold ($r = .23$, $p < .01$). The correlation between perceived engagement (a confirmation item) and posttest scores of conceptual understanding yielded a slightly stronger relationship ($r = .30$, $p < .01$). Perceived engagement, as measured by the confirmation item for how engaged individuals perceived to be in the

Table 1
Means and standard deviations of variables by condition.

	Utility value		Attainment value		Control	
	M	*SD*	*M*	*SD*	*M*	*SD*
Conceptual knowledge pretest (max. possible score of 16)	6.54	2.86	8.55	3.53	7.96	2.86
Conceptual knowledge posttest (max. possible score of 16)	12.28	2.14	12.54	3.07	10.47	3.71
Utility value pretest (max. possible score 42)	34.70	6.12	33.78	6.22	34.05	5.11
Utility value posttest (max. possible score of 42)	36.37	6.00	35.72	5.97	35.23	6.20
Attainment value pretest (max. possible score of 42)	30.96	6.15	29.18	7.35	29.01	6.92
Attainment value posttest (max. possible score of 42)	31.54	7.34	30.13	7.30	29.81	7.27
Deep cognitive engagement (max. possible score of 49)	37.65	7.58	36.74	7.22	35.60	7.37
Shallow cognitive engagement (max. possible score of 28)	18.46	5.81	16.80	5.70	17.93	4.91
Utility approach[a] (max. possible score of 7)	5.28	1.53	4.57	1.63	4.42	1.60
Attainment approach[a] (max. possible score of 7)	4.92	1.65	4.55	1.42	4.40	1.72
Perceived conceptual change[a] (max. possible score of 7)	5.42	1.33	4.67	1.66	4.61	1.57
Perceived engagement[a] (max. possible score of 7)	5.60	1.28	5.18	1.37	4.54	1.66
Overall diff. in utility value (posttest–pretest)	1.67	4.23	1.94	2.74	1.18	4.02
Overall diff. in attainment value (posttest–pretest)	.57	4.82	.94	4.42	.79	3.95
Overall conceptual change (posttest–pretest)	5.74	3.05	3.98	3.19	2.51	2.80

[a] These refer to the confirmation questions asked toward the end of the survey.

Table 2
Correlation matrix of variables ($n = 178$).

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Utility condition [dummy]	1														
2. Attainment condition [dummy]	−.49	1													
3. Control condition [dummy]	−.51	−.51	1												
4. Pretest conceptual knowledge	−.25**	.19*	.06	1											
5. Posttest conceptual knowledge	.11	.16*	−.3**	.51**	1										
6. Perceived utility pretest	.06	−.05	−.02	.18*	.21**	1									
7. Perceived utility posttest	.07	.16*	−.06	.17*	.29**	.80**	1								
8. Perceived attainment pretest	.13	−.05	−.07	.13	.03	.76**	.62**	1							
9. Perceived attainment posttest	.10	−.03	−.07	.11	.11	.66**	.71**	.81**	1						
10. Deep cognitive engagement	.10	.01	−.10	.12	.23**	.59**	.66**	.59**	.62**	1					
11. Utility approach	.23**	−.08	−.15	.05	.09	.52**	.48**	.51**	.51**	.41**	1				
12. Attainment approach	.13	−.03	−.10	.04	.06	.53**	.50**	.69**	.73**	.50**	.55**	1			
13. Perceived engagement	.23**	.04	−.27**	.06	.30**	.46**	.55**	.46**	.55**	.54**	.41**	.54**	1		
14. Perceived conceptual change	.24	−.10	−.13	−.33**	.09	.21**	.22**	.18*	.25**	.30**	.26**	.26**	.51**	1	
15. Overall conceptual change	.36**	−.01	−.34**	−.44**	.55**	.05	.14	−.10	.01	.13	.05	.03	.25**	.42**	1

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

reading task, also had a significant positive relationship with participants' overall conceptual change (the difference between posttest and pretest scores of conceptual understanding). Due to the clearer relationship between perceived engagement and the outcome variables of interest, perceived engagement was used in subsequent analyses that compared participants by condition on engagement.

Other notable relationships include the significant positive correlations among utility condition and utility approach (a confirmation question) ($r = .23$, $p < .01$), perceived engagement ($r = .23$, $p < .01$), and overall conceptual change ($r = .36$, $p < .01$). These relationships suggest that participants in the utility condition yielded greater scores on utility approach, perceived engagement, and overall conceptual change. The attainment condition variable did not yield any significant relationships with these same variables. The control condition demonstrated negative correlations with the same variables. The absence of statistically significant correlations between the conditions and pretest/posttest measures for utility value and attainment value indicates that the task-value measures would not allow us to confirm whether our task value conditions for utility and attainment adopted task-values consistent with their induction. Similar to Linnenbrink and Pintrich (2002) who did not report statistical differences between the mastery and performance goal conditions on measure of achievement goals, we believe that the confirmation items for utility approach, attainment approach, and open-ended item response to "overall goal," would provide richer information in determining the effectiveness of the task-value instructional inductions.

9. Effectiveness of the task value inductions

The first research question of this study was "would the participants in the utility, attainment, and control conditions differ in task values?" To determine whether the conditions differed in their task values, we conducted a series of analyses on multiple indicators of participants' task values, including participants' responses regarding their approaches to the reading task as determined by the confirmation items. We began by comparing conditions on their perceived utility and attainment value scores (pretest and posttest); however, no statistical differences were observed. Despite our attempts to modify the MSLQ items for task value in a manner that could give us a reliable assessment of participants' utility and attainment values, like Linnenbrink and Pintrich (2002), we were not able to observe any statistical differences between our conditions on their motivational perspectives using this measure. The absence of statistical differences can suggest that it may take longer than just one reading and one task to alter a learner's task value for a specific topic. Having planned for alternative indicators of participants' task values, we turned our attention to analyzing participants' responses to how they approached the learning task.

Two one-way ANOVAs were employed to determine whether the participants in the three conditions differed in their utility approach or attainment approach.[4] In the first one-way ANOVA where the conditions were designated as the independent variable and the utility approach variable as the dependent variable, a statistically significant difference among the participants in the utility, attainment, and control conditions was observed, $F(2,162) = 4.52$, $p = .01$, $\eta^2 = .05$, with a modest effect size. Tukey Post-hoc comparisons suggest that those in the utility condition ($M = 5.28$, $SD = 1.53$) had significantly higher scores for their utility approach than did those in the control condition ($M = 4.42$, $SD = 1.60$) ($p = .02$). The utility condition did not statistically differ from the attainment condition ($M = 4.57$, $SD = 1.63$) ($p = .07$). In an ANOVA, where the conditions were the independent variable and the attainment approach variable served as the dependent variable, no statistically significant differences were found.

Further evidence regarding the effectiveness of the inductions can be gleaned from an analysis of participants' responses to the open-ended confirmation item meant to elicit responses as to what participants were trying to accomplish during the reading task. Two raters coded students' responses and were blinded from knowing which conditions participants were assigned. An initial round of coding yielded an inter-rater reliability of .91, at which point both raters met to justify their codings until 100% agreement was reached. In response to the item, 48.1% of the participants in the utility condition indicated that they wanted "...to understand the text so I could apply it to my career as a teacher," compared to 11.5% from the attainment condition and 21% from the control condition. The most common response to the same question for the participants in the attainment condition (59.6%) was to paraphrase, "I want my performance to be outstanding because my performance is a reflection of me as a student," and/or "to learn the material and do well on the assessment," compared to 20% from the control condition and 15.4% from the utility condition. The most common response from the participants in the control condition (40%) was "to expand my understanding of the common cold," with no further elaboration as to whether understandings would be applied in the future or a whether they felt a need to do well on the assessments. Approximately 23.1% of the participants in the attainment condition and 34.6% of the participants in the utility condition responded similarly. These results suggest that many of the participants' expressions for how they approached the learning task aligned with the task value inductions they received.

10. Task value and engagement for learning

The second research question of this study was "would the participants in the utility, attainment, and control conditions differ in their engagement for the learning task?" We conducted an ANOVA to test the hypothesis that the conditions would differ on engagement. Using condition as the between-subjects variable and perceived engagement as the dependent variable, a statistically significant difference was observed between conditions on their perceived engagement, $F(2,162) = 7.56$, $p = .001$, $\eta^2 = .085$, with a medium effect size. Tukey post hoc comparisons suggest that the utility condition participants rated their engagement as significantly higher ($M = 5.60$, $SD = 1.28$) than those in the control condition ($M = 4.54$, $SD = 1.66$) ($p = .001$). Despite the fact that the participants in the utility condition yielded a higher mean than those in the attainment condition, they did not significantly differ from one another ($M = 5.18$, $SD = 1.37$). Although the attainment condition yielded a higher mean than the control condition, they too did not statistically differ. Nevertheless, the statistical difference between the utility condition participants and those in the control condition suggests that the utility condition participants believed they were more actively engaged with the reading content than those who were not induced with a task value. This result lends some support to the claim that the conditions differed in their approach to the reading; and the different approaches influenced how participants engaged and/or processed the reading content. Compared to the control condition, it appears that inducing participants with a utility value may have facilitated the generation of more meaningful connections with the reading content, thereby allowing for greater opportunities for such participants to engage with the materials.

11. Task value and conceptual change

Analysis of covariance (ANCOVA). With statistical differences being observed among our conditions on their pretest scores for conceptual knowledge, an ANCOVA was performed to determine whether the differences observed among our conditions on their posttest scores for conceptual knowledge would continue to exist after controlling for pretest differences. Using pretest scores as the covariate, condition as the independent variable, and posttest scores as the dependent variable, a statistical difference between our conditions on their posttest scores was found, $F(3,161) = 30.88$, $p = .0005$, $\eta^2 = .365$. The effect size is large. Tukey post hoc comparisons indicate that the utility condition had statistically higher posttest scores ($M = 12.97$, $SD = 3.85$) than the control condition ($M = 10.31$, $SD = 3.66$) when controlling for pretest scores, but the differences between the utility and the attainment condition were not statistically significant ($M = 12.01$, $SD = .38$). The attainment condition, however, had statistically higher posttest scores than the control condition. These results indicate that even when controlling for pretest differences, those induced with a task value were more likely to obtain greater conceptual knowledge than those who are not induced with any value. Of greater interest to

[4] The two one-way ANOVAs were used as fidelity checks to see how the conditions approached the reading task; and not meant to compare conditions on their conceptual change at this point in the results. We do however, compare the conditions on their conceptual change in later analyses.

our research objectives, however, was which group of participants experienced the greatest degree of conceptual change.

ANOVA with difference scores. To test which group of participants experienced the greatest conceptual change, which was our third research question, a one-way ANOVA was employed to determine whether the participants in the utility, attainment, and control conditions statistically differed from one another on overall degree of conceptual change. Using condition as the independent variable and pre to posttest difference scores as the measure of conceptual change, a statistically significant difference was observed among the conditions on their overall conceptual change, $F(2,162) = 15.94$, $p = .01$, $\eta^2 = .16$. This effect size is large. Specifically, the Tukey post hoc comparisons suggest that participants in the utility condition ($M = 5.74$, $SD = 3.05$) demonstrated a statistically greater degree of conceptual change than the participants in both the attainment condition ($M = 3.98$, $SD = 3.19$, $p = .01$), and the control condition ($M = 2.51$, $SD = 2.80$, $p = .01$). The participants in the attainment condition also showed statistically greater conceptual change over those participants in the control condition ($p = .03$). Overall, these results suggest that the participants in the utility condition demonstrated the greatest degree of conceptual change, followed by those in the attainment condition. The control condition participants demonstrated the least conceptual change.

12. Discussion

The goal of this study was to test the hypotheses of three research questions regarding task value inductions and their relation to engagement and conceptual change. All three of our hypotheses regarding these questions found some support. First, we sought to investigate whether task values could be instructionally induced. The results of both the quantitative and qualitative findings suggested that many of our participants appeared to have adopted an approach to the reading task in a manner consistent with the task value being induced. It should be acknowledged, however, that not all participants were successfully induced as evidenced by participants' quantitative self-report responses. Nevertheless, when triangulated with participant's qualitative responses, many expressed that they favored the task value they were induced with when they approached the reading task. We interpret these findings as showing support for our hypothesis that the task values can be instructionally induced and that such inductions have the potential to alter participants' approaches to a learning task.

Next, we investigated whether induced task values related to engagement with the learning task. We hypothesized that differences among the participants in the three conditions would emerge based on Dole and Sinatra's (1998) CRKM, which described motivation (i.e. task values, goal orientations, interest, etc.) as a mechanism that can instigate and sustain the engagement necessary to facilitate conceptual change. Results indicated that the participants in the utility condition perceived their engagement to be greater for the reading task than those in the control condition. We interpret this result as suggesting that the utility induction may have been more effective in promoting engagement than not using any task value induction.

Finally, we sought to investigate whether induced task values related differentially to degree of conceptual change. Overall, participants in all three of the conditions experienced conceptual change as evidenced by gains from pre- to posttest on scores of conceptual understandings about the causes of the common cold. This is not surprising since they all read a refutation text designed to promote conceptual change and such text have previously demonstrated to be effective (Hynd, 2001). Our interest however, was the potential impact of induced task values on the conceptual change process. Statistical tests revealed that the utility condition participants experienced the greatest amount of conceptual change, followed by those in the attainment condition, with the participants in the control condition experiencing the least amount of conceptual change. We interpret our results, taken together, as suggesting that inducing students with a task value is more effective in facilitating engagement and conceptual change than not inducing students with a task value.

Our results can be used to inform the generation of new conceptual change models that take into account the role of task values in the conceptual change process. The findings from this study extend the "warming trend" (Sinatra, 2005) in conceptual change research by demonstrating not only that motivation plays a role, but also in describing more specifically, how task values make an impact. Evidence suggests that motivational conceptual change models should consider taking task values into account because task values may facilitate conceptual change by allowing learners to make more meaningful connections between new concepts and ideas they encounter or may already know. Conceptual change theorists should also consider how different task values might result in different patterns of change. As previously stated, both utility and attainment values are motivating factors and in this study both values appear to facilitate conceptual change; however, they may draw learners' attention to varying components of a challenging conceptual task and experience conceptual change differently. For example, a student who has a strong utility value for a task may feel compelled to focus solely on conceptual components that may be useful or relevant to their current situation and/or future career pursuits, whereas a student high in attainment value may focus on the things that might align with the goal of protecting one's self-schema. In either case, because background knowledge might be activated (i.e. self-schema, career pursuits, etc.) with either value at the time a learner is engaged in a conceptually challenging task, more meaningful connections can be made, than when no task value is induced. An absence of any type of task value is perhaps the poorest facilitator of conceptual change because of the lost opportunity to capitalize on the meaningful connections to prior knowledge activated by adopting a task value. Future research is needed to confirm that such results are consistently obtainable, but if further support is found for the differential impact of task values, a model of conceptual change that accounts for the task values may provide a better account of motivated conceptual change and more fully explain the behavior and experiences of learners during the conceptual change process.

Additionally, our results show support for the connection between engagement and conceptual change as hypothesized in Dole and Sinatra's CRKM (1998). The observed difference between the utility and control condition on perceived engagement, as well as the significant correlation between perceived engagement and overall conceptual change supports the hypothesis that engagement may be a mediating factor between motivation and conceptual change. The utility condition, which experienced the greatest amount of conceptual change, perceived that they were more actively engaged with the reading material than the control condition.

Another theoretical implication is that expectancy-value models of motivation may need to consider the role of engagement in predicting achievement related outcomes (i.e. conceptual learning). Eccles and Wigfield (2002) posit expectations of success and task values as mechanisms that lead to and predict achievement related outcomes. Such an expectancy-value model of motivation does not illustrate how the differing task values may activate different levels of engagement or cognitive processes that may ultimately result in different achievement related outcomes. The finding from this study suggests that a utility value may be a strong predictor of achievement because it may activate engagement. Although future research should more fully explore the role of engagement in an expectancy-value model of motivation, we argue that expectancy-value theorists may better predict achievement related outcomes if they account for engagement.

Finally, we also see the results of this study as having practical relevance for conceptual change pedagogy. Our results suggest that merely stressing task values (specifically a utility and/or attainment) may be advantageous ways to promote the adoption of utility and/or attainment oriented approaches to motivated conceptual change. Participants in the utility condition were instructed to "find the information useful to your future career pursuits." Participants in the attainment condition were instructed to "…take into account the importance of doing well on the tasks that follow." In classroom settings, an incorporation of these utility and attainment-oriented phrases is a relatively easy and brief instructional action that may make the adoption of such task values by students more likely.

Inducing task values may also promote engagement in tasks other than those calling for conceptual change. According to the work of Greene and her colleagues (Greene et al., 2004; Greene & Miller, 1996) engagement is associated with positive learning and achievement outcomes. Our findings suggest that engagement maybe bolstered by stressing of a utility value for a task. Taking into account the work of Greene and her colleagues, if an emphasis on utility values bolsters engagement, and engagement garners greater achievement, then an emphasis on utility values should evidence higher levels of achievement. In fact, this reasoning resonates with Miller et al.'s (1996) claims that the engagement necessary to produce meaningful learning can be supported by values of utility. We would agree with Cole et al. (2008) that stressing no task values for a learning task could be a missed opportunity for students' learning, since utility and attainment values might play a meaningful role in the learning and conceptual change process.

12.1. Limitations and future research

All studies have limitations and ours is no exception. To reduce threats to validity, a pretest–posttest control group experimental design was employed; participants were randomly assigned to conditions; and a control condition was used to help ensure that any differences observed in comparing the conditions were due to the instructional inductions. Nevertheless, pretest differences on conceptual understandings of the common cold were observed and had to be controlled in our analyses. Thus, future studies may consider obtaining larger samples. The lack of statistical differences observed between the utility and attainment conditions on engagement suggest that either may be employed to enhance a learner's engagement on a task, however, further investigation is needed to determine whether utility and attainment values differ sufficiently and consistently from one another to differentially influence conceptual change learning. The absence of statistical differences between our conditions on their utility and attainment values scores from the modified MSLQ subscales was also a limitation to this study. Based on the results of our correlation analyses, perceived utility and attainment values at pretest and posttest are strongly related, which begs the question of whether the two values can be isolated from one another. Nevertheless, our results indicate that those induced with either task value had an advantage in experiencing conceptual change compared to those not induced with values. Therefore, future research may consider employing alternative strategies to assessing, measuring, and/or defining specific task values.

Another limitation of this study stems from the self-report nature of its instruments and absence of behavioral data. Although qualitative and quantitative data were triangulated to validate differences among the participants in each condition on how they approached the reading task, future research could be strengthened by behavioral data. Although the use of self-report measures, like the ones used in this study, can be convenient and have moderate convergent validity with similar measures (Richardson, 2004), methodological limitations remain a concern as to the extent to which self-report measures accurately reflect real-world behaviors (for more on the concerns of self-report measures in education, see Fulmer & Frijters, 2009; Karabenick et al., 2007; Mayer et al., 2007).

Future research efforts should consider the inclusion of alternative student populations (i.e. different developmental levels or disciplines of study) and different content areas. The utilization of different student populations and different content areas would allow future researchers to determine whether stressing a specific task value is effective in promoting conceptual change for particular students, for particular concepts, and/or for particular pairings of students and concepts (i.e. stressing a utility value for a task on the trajectory of falling objects, to English majors). More in depth investigations into the potency and effectiveness of task value instructional inductions are also needed to better determine whether conceptual change can be further enhanced.

Additional research questions we consider fruitful to pursue include: How long can a task value be emphasized before it no longer acts as a motivator? Would the stressing of multiple values be more advantageous than the stressing of a single value? Future research investigating the effectiveness, stability, and potency of task value inductions can have practical implications for how educators motivate their students and facilitate conceptual change. Furthermore, future research regarding the identification of psychological mechanisms that can be activated and sustained by certain task values, would help improve the theoretical models of conceptual change, as well as allow conceptual change scholars to better predict and understand the patterns of behaviors and experiences learners encounter during motivated conceptual change.

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Appendix A. Sample sections of the refutational text "Causes of the Common Cold"

A.1. Causes of the common cold

Some people believe that bacteria cause the common cold. But, actually, it is viruses, and viruses alone that cause the common cold. The common cold is a contagious, viral infectious disease of the upper respiratory system primarily caused by a category of viruses called rhinoviruses; though there are over 200 different viral types that can cause colds. Rhinoviruses ("rhinos" Greek meaning nose) attach, enter, and replicate inside of cells in the back of a person's nose. The back of the nose is an ideal place for this category of viruses to reside because the temperature is a few degrees cooler than the rest of the body. Rhinoviruses fail to efficiently replicate at a person's regular body temperature, and orally ingesting rhinovirus contaminated items does not typically lead to an infection. Unlike other viruses, like the human immunodeficiency virus (HIV), rhinoviruses remain localized. The fatigue and muscle discomfort some people experience with the common cold can be attributed more to the body's immune response, and is not due to the virus traveling in one's blood stream. Many people believe antibiotics are needed to treat colds, and even seek antibiotic prescriptions from their doctors. Unfortunately, antibiotics are ineffective in treating the common cold because antibiotics (''anti'' meaning ''against''; and ''bios'' meaning ''life'') are substances that inhibit the growth and/or kill bacteria, not viruses. Unlike bacteria, viruses lack a cell body (which is considered the most basic unit of life) and cannot grow or reproduce on their own; and for these reasons are not even considered living organisms. Instead, a virus needs a host cell to attach to, enter, replicate itself, and burst out of to then infiltrate other cells. Misusing antibiotics to treat viral infections may actually do more harm than good, since they can contribute to building a person's antibiotic resistance, thereby making it difficult for such individuals to combat future bacterial infections.

Appendix B. Sample of conceptual assessment questions

B.1. True/false

1. One can catch a cold from ingesting food that an infected person has touched (False).
2. A cold is caught from being exposed to wet and chilly weather (False).
3. Antibiotics are effective in treating the common cold (False).
4. There is NO known cure for the common cold (True).
5. Bacteria are the leading cause of catching the common cold? (False).

B.2. Multiple-choice

6. What is the greatest limitation about using vaccines as a preventative measure for the common cold?
   a. Vaccinations are only available for the flu and not the common cold.
   b. A single vaccine CANNOT account for the variety and constant mutations of cold causing agents.
   c. Individuals may actually catch the common cold from a vaccination.
   d. All of the above are limitations.
   e. All of the above statements are NOT true.
7. Which of the following can contribute the most to a child catching the common cold?
   a. Going outside with wet hair in cold weather.
   b. Walking outside barefoot.
   c. Teething.
   d. All of the above are equally feasible contributors.
   e. None of the above are contributors.
8. The BEST measure to prevent children from catching the common cold, is to:
   a. Keep children indoors with others.
   b. Promote appropriate hand hygiene techniques.
   c. Keep children bundled up when they are outdoors.
   d. Have children take cold medicines before they catch it.
   e. Use aerosol fresheners frequently and often.

Appendix C. Task value instructions induction

C.1. Instructional induction for the utility condition

Jordan is an education major who is taking a microbiology course to fulfill a required science credit. A portion of the course is dedicated to the causes of the common cold. Jordan's goal is to connect everything he learns in the course to issues involving children's health that may be useful to him once he becomes a teacher. Jordan finds the material to be useful for understanding what measures to take to prevent illness in his future students, how to respond to ill students, and how to stop the spread of colds and other illness in his classroom. Jordan connects all of the microbiology materials to educational situations. Jordan is motivated to learn more about microbiology because of its relevance and utility to his future career as a teacher.

1. Do you know people like Jordan, who always find ways to make course materials useful and applicable to their future pursuits?
2. Think back to a time when you felt and/or behaved like Jordan. Write a sentence or two about how you felt, behaved, or acted like Jordan.
3. I will be giving you a reading about the causes of the common cold. After you've done the reading, I will give you a set of questions to respond to pertaining to the causes of the common cold. Please read the passage carefully so that you really learn and understand the ideas in it. You may go back and review the passage so that you can really try to understand it; once you've started answering questions that follow the passage, you may not return to the passage. While you are reading the passage, consider how the information can be applied to future situations. Approach the reading task like Jordan. I will be interested to see if, for the remainder of this survey, you can find the information useful for your future career pursuits. To show that you understand this, please state in a sentence or two what your goal is.
4. In what ways could knowing the causes of the common cold be useful to your future career pursuits?

C.2. Instructional induction for the attainment condition

Jordan is an education major who is taking a microbiology course to fulfill a required science credit. A portion of the course is dedicated to the causes of the common cold. Jordan's goal is to demonstrate that he is a good student. Doing poorly in the course would be a bad reflection upon Jordan's academic abilities. Jordan finds it important to do well in the course and believes that the subject matter is important. Jordan is motivated to demonstrate competence in this course.

1. Do you know people like Jordan, who believe that a poor performance would be a bad reflection of their academic abilities?
2. Think back to a time when you felt and/or behaved like Jordan. Write a sentence or two about how you felt, behaved, or acted like Jordan.
3. I will be giving you a reading about the causes of the common cold. After you've done the reading, I will give you a set of questions to respond to pertaining to the causes of the common cold. Please read the passage carefully so that you can later demonstrate your ability to be a good student. Once you've started answering questions that follow the passage, you may not return to the passage. While you are reading the passage, consider how Jordan would approach this reading. I will be judging you based on your performance. For the remainder of this survey, take into account the importance of dong well on the tasks that follow because I will be interested to see how well you perform on the tasks. To show that you understand this, please state in a sentence or two what your goal is.
4. In what ways could your performance on an assessment about the causes of the common cold, be a reflection of your academic abilities?

Appendix D. Task-value, engagement, and confirmation items

D.1. Utility value items (1–7 Likert scale)

1. I think I will be able to use what I learn in this reading in other occasions.

2. Knowing what causes the common cold is useful information.
3. I think the reading material in this study is useful for me to learn.
4. My learning about what causes the common cold can be applied in future circumstances.
5. Mastering the ideas about what causes the common cold will be helpful in the future.
6. Knowing what causes the common cold can be useful information to teachers.

D.2. Attainment value items (1–7 Likert scale)

1. Doing well on the reading task is important because my performance is a reflection of who I am.
2. Doing well on the assessments pertaining to the causes of the common cold is important to me.
3. My performance in knowing what causes the common cold is important.
4. It is important for teachers to do well on assessments, especially those concerning issues of health.
5. Understanding the subject matter of this reading is very important to me.
6. It is important for me to learn the material in the reading.

D.3. Deep cognitive engagement items (1–7 Likert scale)

1. I tried to combine different pieces of information from the text in new ways.
2. I sometimes reflected on my understanding of the common cold to see if it matched what was presented in the reading.
3. When I came across new information presented in the text, I summarized it in my own words.
4. Sometimes I recognized that my way of thinking about how people catch the common cold was inconsistent with what was presented in the reading.
5. When I came across new information presented in the text, I tried to connect it with things I already know and am familiar with.
6. I tried to identify the big picture about what causes the common cold.
7. I compared my personal understanding about common colds to what was presented in the reading.
8. After I completed the reading, I felt like I was able to better conceptualize what causes the common cold.
9. I applied what was presented in this reading to my observations of the real world.
10. When I read for the previous text, I stopped to ask myself whether or not I understand the material.
11. To understand the material, I thought about my personal experiences and related them to the reading about the causes of the common cold.

D.4. Shallow cognitive engagement items (1–7 Likert scale)

1. I tried to memorize the exact steps for the progression of the common cold.
2. I tried to memorize answers to previously asked questions presented in the text.
3. In order for me to understand what technical terms meant, I memorized the definitions given in the text.
4. I tried to memorize the key points presented in the text.
5. I tried to remember exactly what was presented in reading material.

D.5. Confirmation items (1–7 Likert scale)

1. Was your primary goal to relate the material to issues that are useful to your career or future pursuits?
2. Was your primary goal to do well on the task because it was on important information?
3. Was your primary goal to get through the reading?
4. To what degree do you think you've changed in your knowledge about the causes of the common cold?
5. How engaged were you in the reading on the causes of the common cold?
6. In a sentence, please describe your overall goal for the previous reading task *(open-ended item).*

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