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Outcomes from a self-generated utility value intervention on fifth and sixth-grade students' value and interest in science

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ABSTRACT

The purpose of this field experiment was to understand whether fifth and sixth-grade students were able to write about the usefulness and relevance of what they were learning in their science class through self-generated reflections and to examine the impacts of this activity on students' value, utility value, and interest for science. Analysis of students' essays revealed in the self-generated reflection condition students connected what they were learning to their lives significantly more than the control condition. Linguistically, student essays did not differ between the two conditions, except for cognitive processing. Self-reflecting increased students' utility value but not value nor interest. Self-efficacy did not moderate these relations. Implications for extending self-generated utility value and broader social-psychological interventions for early adolescent students are discussed.

1. Introduction

Promoting student retention, performance, and careers in science, technology, engineering, and mathematics (STEM) is becoming increasingly important due to the national and international need for STEM workforce (National Academy of Sciences, National Academy of Engineering, & Institute of Medicine, 2005; National Academy of Engineering & National Research Council, 2014; OECD, 2016). A key antecedent for these attainments is student motivation (Anderman & Young, 1994; Linnenbrink-Garcia, Pugh, Koskey, & Stewart, 2012; Simpkins, Davis-Kean, & Eccles, 2006).

Research (e.g., Hulleman, Godes, Hendricks, & Harackiewicz, 2010) suggests that interventions can be successful in getting students to be more interested in or find more value in certain school subjects. One type of intervention that produced promising results in formal school settings is social-psychological interventions (e.g., Haynes, Perry, Stupnisky, & Daniels, 2009; Hulleman et al., 2010; Lazowski & Hulleman, 2016; Yaeger, Walton, & Cohen, 2013). The present study focuses on a self-generated written reflection activity (i.e., a utility value intervention), which have demonstrated efficacy in enhancing students' interest, value, and performance in a variety of STEM disciplines (e.g., biology, mathematics, science) in high school and undergraduate contexts (e.g., Hulleman et al., 2010; Hulleman & Harackiewicz, 2009).

One area where the effectiveness of these interventions has not yet been explored is among middle school students. This is an especially sensitive period where students' intrinsic motivation is beginning to decrease (e.g., Lepper, Corpus, & Iyengar, 2005). This

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problem is salient with concern to science content areas (Anderman & Young, 1994; Lee & Anderson,1993; National Research Council [NRC], 2007; Vedder-Weiss and Fortus, 2011, 2012). Notably, despite the sensitive academic period, little research has examined the benefits of administering a utility value intervention with children. As such, the purpose of this study is to investigate the effectiveness of a utility-value intervention with fifth and sixth-grade students in science.

2. Theoretical framework

There are numerous theoretical frameworks that can be used to situate and explain the role of motivation in students' learning and achievement in STEM domains. The present study focuses on the expectancy-value theory (Eccles & Wigfield, 1995), and Hidi and Renninger's (2006) model of interest development primarily because of the alignment between these theoretical perspectives and the social-psychological intervention employed, namely a utility value intervention.

2.1. Expectancy-value theory

The expectancy-value theory posits that an individual's perception of expectancy for success (e.g., "Can I do this?") and their subjective task value (e.g., "Do I want to do this?") are proximal antecedents of achievement-related outcomes and choices (Eccles & Wigfield, 1995; Eccles et al., 1983; Wigfield & Eccles, 2000). Within this theoretical framework, expectancy beliefs are defined as an individual's judgment of their anticipated level of achievement on an upcoming task. In addition to expectancy for success, four types of task values are proposed: attainment, intrinsic, cost, and utility value. Since the present study focuses on the latter, only utility values will be discussed (for a more comprehensive review of task values see Eccles et al., 1983; Flake, Barron, Hulleman, McCoach, & Welsh, 2015; Wigfield & Eccles, 1992).

Utility value refers to the perceived usefulness or relevance of the task or activity for one's future plans and, consequently, involves a focus on the desired end state. For example, learning about the skeletal system should be perceived as especially useful for a student who is planning on becoming an x-ray technician. Together, students' expectancy for success and task-values predict important learning related outcomes, including achievement emotions, academic achievement, and interest (Bieg, Goetz, & Hubbard, 2013; Hulleman, Durik, Schweiger, & Harackiewicz, 2008).

2.2. Interest and interest development

In addition to the expectancy-value theory, theories of interest and interest development are also relevant in guiding the present study. Interest can be defined as the psychological state and a tendency to continue engagement with tasks (Hidi & Renninger, 2006). Interest predicts a variety of adaptive learning related outcomes, including, for instance, students' attention, goals, and academic achievement (e.g., Hidi & Renninger, 2006; Hulleman et al., 2010; Mitchell, 1993), and, therefore, is a critical component of students' motivation to learn (Brophy, 1999).

According to Hidi and Renninger's (2006) model of interest development, interest develops in four distinct and sequential phases: *triggered situational interest, maintained situational interest*, *emerging individual interest*, and *well-developed individual interest*. A crucial component in the development of interest from initial situational interest to well-developed individual interest is finding personal meaning and relevance with a task (Hidi & Renninger, 2006; Hulleman et al., 2008; Hulleman & Harackiewicz, 2009). The four-phase model of interest development and the expectancy-value theory offer complementary explanations for how generating utility rationales relate to persistence, learning, and achievement in academic domains and have consequently been critical in the design of utility value interventions.

2.3. Utility value interventions

Over the past ten years, there has been substantial interest in the design and implementation of brief social-psychological interventions in education as tools to target important psychological processes (Yeager & Walton, 2011). These interventions are designed to change how students (or parents) think or feel in relation to academically relevant concepts. The effectiveness of social-psychological interventions in education relate to the psychological precision and theoretical grounding of the targeted process, the ease of administering the intervention material, and the extent to which the focal construct is a recursive process (Paunesku et al., 2015; Yeager & Walton, 2011). One commonly investigated brief social-psychological intervention is utility value interventions.

Utility value interventions consist of either directly telling, or having students generate their own reasons for why the learning content is relevant or useful in their lives (e.g., Kale & Akcaoglu, accepted; Durik & Harackiewicz, 2007; Durik, Shechter, Noh, Rozek, & Harackiewicz, 2015; Godes, Hulleman, & Harackiewicz, 2007; Hulleman et al., 2010; Hulleman & Harackiewicz, 2009). These interventions are situated within the expectancy-value theory (Eccles & Wigfield, 1995) and the four-phase model of interest development (Hidi & Renninger, 2006). According to these theoretical perspectives, having students reflect on the usefulness of learning the content should increase the perceived utility value and should initiate situational interest, which in turn should lead to an increase in maintained interest, effort, and learning. The self-generated approach to manipulating students' utility value involves asking students to identify reasons why the learning content is useful in their lives, often in a writing task (e.g., Hulleman et al., 2010). This intervention is particularly effective at increasing interest and achievement of students with low perceived competence. The directly-communicated utility value intervention entails directly telling students why the learning content will be useful (e.g., Durik et al., 2015). In contrast to the self-generated version, this intervention is especially effective at increasing interest and achievement among students with high perceived competence (see Canning & Harackiewicz, 2015 for a comparison of self-generated and directly communicated approaches). In the present study, we focus on the self-generated version of the utility value intervention.

2.4. Declines in motivation to learn science during adolescence

In a recent meta-analysis that investigated a broad array of motivational interventions in education across various age groups, expectancy-value and interest-based interventions (i.e., utility value interventions) were identified as effective approaches to increase interest and academic achievement in educational settings (Lazowski & Hulleman, 2016). Notably, only ten out of 92 studies included in the meta-analysis were conducted with elementary school aged students, and none of these ten studies involved utility value interventions. The results from this meta-analysis suggest that utility value interventions are associated with medium effect sizes (ranged from 0.39 to 0.69), which is noteworthy for several reasons. First, the results from this meta-analysis suggest that other social-psychological interventions are effective with elementary school-aged children, with an average effect size of 0.52. This indicates that it is possible and beneficial to implement social-psychological interventions with this age group. Second, an underlying explanation for why brief motivational interventions are effective relates to the recursive outcomes that are targeted (Cohen, Garcia, Purdie-Vaughns, Apfel, & Brzustoski, 2005; Paunesku et al., 2015; Yeager & Walton, 2011). Consequently, intervening at a younger age should be especially beneficial, as earlier gains should compound over time. Finally, from a practical perspective, utility value interventions require “little or no money to implement” (Lazowski & Hulleman, 2016, p. 25) and therefore can be conveniently integrated into existing classrooms and curricula. Given these concerns, the goal of the present study is to extend prior research by investigating the impact of utility value interventions with elementary age students in science, a subject that is crucial for the STEM workforce and innovation.

It should be also noted that the decline in students’ motivation to learn school subjects, especially science (the context of the current study) is acute especially during adolescence (Gnambs & Hanfstingl, 2015; Vedder-Weiss & Fortus, 2011,2012). This is a universal problem, regardless of national contexts. For example, in their studies, Fortus (2011, 2012); found that students’ motivation to learn science showed a significant decline from 5th to 8th grade, when students were transferring from elementary to middle school. Gnambs and Hanfstingl (2015) observed similar findings in their study, where there was a decline in adolescents’ intrinsic motivation to learn. In a similar vein, Wijsman, Warrens, Saab, van Driel, and Westenberg (2016) pointed to the importance of meeting students’ psychological needs and highlighted utility value as an important motivation factor. Furthermore, Wijsman et al. (2016) propose that students might find less connection between what they are learning in school and their daily lives as they grow up. The authors specifically argue that utility value interventions (e.g., Hulleman et al., 2010) can be implemented in schools to help establish personal relevance. In the current study, we aimed to target a vulnerable age group in terms of their motivation to learn with an empirically-supported instructional intervention.

3. The present study

The purpose of this study was to investigate the generalizability and effectiveness of a self-generated utility value intervention in a sample of fifth and sixth-grade students in their science courses. Since this was the first time that a self-generated utility value intervention has been implemented with a younger sample, it was important to carefully evaluate if the intervention was functioning in the same way with this new demographic group as with the older samples more commonly investigated. One concern with extending prior work from an older sample (i.e., high school- and college-aged students) to a younger sample (i.e., the fifth and sixth grade students in the present study) is the difference in writing proficiency (McCutchen, 2011) and ability to hypothetically project into the future, which could compromise the effectiveness of this intervention. Therefore, the first goal of the present study is to evaluate the fidelity of the treatment of the utility value instructions. Specifically, it is necessary to first ensure that younger students follow the instructions and actually reflect on the usefulness of the learning content in their lives. Therefore, the first research question was:

- Does a self-generated utility value intervention increase the connections that students make between school science content and outside of class contexts?

Students' written responses are an essential component of the actual self-generated intervention, but can also be used as a data source to assess the fidelity of the utility value intervention as well as provide insight into what topics students write about. Although some studies have analyzed written responses to intervention prompts to determine how the intervention might impact (or fail to impact) student outcomes, the majority of the research on social psychological interventions in general, and utility value interventions, in particular, have not analyzed students’ written responses in terms of their content and psychological constructs they elicit (Kafkas, Schmidt, Shumow, & Durik, 2017), though this is changing as a result of some recent work (Canning & Harackiewicz, 2015; Harackiewicz, Canning, Tibbetts, Prinski, & Hyde, 2016). Recent research has pointed to the value of computational methods for understanding phenomena related to teaching and learning. In particular, computational approaches to understanding text, *Natural Language Processing*, have increasingly been used as a strategy for understanding students' conceptual understanding (Sherin, 2013), inquiry-related practices (Gerard et al., 2016), and, even, the constructs elicited in written responses from students participating in a utility value intervention (Canning & Harackiewicz, 2015; Harackiewicz et al., 2016). In fact, in prior research, the content of written self-generated utility value interventions (e.g., Canning & Harackiewicz, 2015; Harackiewicz et al., 2016) was analyzed using the computational text analysis Linguistic Inquiry and Word Count software (LIWC, Pennebaker, Boyd, Jordan, & Blackburn, 2015), and as such provides a template for replication and extension. Accordingly, we included constructs from these past research studies and added the summary language variables available in the new LIWC 2015 software (Pennebaker et al., 2015). To investigate the content of students' written responses and to compare responses between students in the treatment and control conditions, the second research question was:

- Is there a difference in psychological processes elicited as assessed through students' written responses between the control and experimental conditions?

In addition to analyzing students' written work, our main purpose in this study was to investigate the motivational outcomes from this treatment. In line with prior research (e.g., Hulleman et al., 2010), we hypothesized that the intervention would enhance students' perceived utility value and interest, and that the effectiveness of the intervention for these outcomes would be moderated by students' self-efficacy, such that students with lower self-efficacy would benefit more from the intervention than those with higher self-efficacy. Notably, it is proposed that the benefits of the utility value intervention would be similar for this sample of younger students, as for those reported among high school and undergraduate students (e.g., Hulleman et al., 2010; Hulleman & Harackiewicz, 2009). The third and fourth goals of this study were to assess the effectiveness of the self-generated utility value intervention. Therefore, the third and fourth research questions focus on the impact of the intervention on students' perceived utility value and interest:

- Does a self-generated relevance intervention increase fifth- and sixth-grade students' perceived utility value and interest?
- Does self-efficacy moderate the effect of the intervention on students' perceived utility value and interest?

4. Method

A between groups, pre- and post-test experimental design was used to investigate the effects of a self-generated utility value intervention with students in eight science classrooms, with students randomly assigned to either the control or experimental condition. Teachers were aware that there were two different writing tasks, however, they remained blind to the underlying purpose of the study and who was assigned to each condition. Following from prior research procedures (see Hulleman & Harackiewicz, 2009), the treatment condition consisted of a writing task prompting students to make connections between school science content and outside of class contexts, whereas the control condition consisted of a writing task focused around summarizing what they had recently learned. Data about students' interest and self-efficacy were collected before and after the writing task for students in both conditions.

4.1. Participants and context

The participants were fifth and sixth-grade students ($n = 212$) in a primarily middle to upper-middle-class suburban school in the Midwestern United States. The students were in eight separate classrooms ($M = 26.5$, $SD = 0.93$) taught by four science teachers. Participants were selected from a larger study where reform-based science units (Berland et al., 2016) that went beyond information recall were being implemented during a part of the semester. Unlike traditional science courses, during these units, science practices to generate explanations of phenomena and applications to other real-life contexts were emphasized (Kenyon, Schwarz, & Hug, 2008). It should be noted here that utility value (e.g., finding uses for future life) was not an explicit goal of these units. Rather, the units included connecting scientific topics as they are situated in real-life contexts (e.g., evaporation and condensation).

Each of the four science teachers had two classes participate in this study with a mean of 53 students ($SD = 1.63$) per science teacher participating in the study. Fifty-one percent ($n = 108$) of the participants were in fifth grade, and 49% ($n = 104$) were in sixth grade. Fifty-seven percent ($n = 120$) of the students were female, and 43% ($n = 92$) were male. Four percent of students were 9 years old, 45% ($n = 95$) were 10 years old, 46% ($n = 97$) were 11 years old, and 6% ($n = 12$) were 12 years old.

4.2. Measures

For students in both the treatment and control conditions, we used measures of self-efficacy, value (including items for utility value), and interest. Item responses for each scale were summed and averaged to form four composite variables: self-efficacy (pre-only), value and, its subsection, utility value (pre and post), and interest (pre and post). The survey was designed to account for the age of the students. For example, varying sizes of stars (small to large) were used instead of numbers in the Likert-scale (Appendix A).

Self-efficacy in science was measured by a five-item Likert scale developed by Midgley et al. (2000). Students indicated their agreement with the statements (e.g., "I'm certain I can master the things taught in science this year") by selecting a point on the seven-point scale (1 = strongly disagree, 7 = strongly agree). The reliability for this scale was satisfactory ($\alpha = 0.85$).

Utility value in science was measured by an eight-item scale developed by Ryan (1982). Similar to the self-efficacy scale, the items sought a response on a seven-point Likert scale. After comparison to the recent utility value items developed by Hulleman et al. (2010), however, we noticed that some of the utility value items used in Ryan's (1982) Intrinsic Motivation Inventory referred to a more general value (e.g., "I believe taking this science class was beneficial to me") rather than utility value (e.g., "I think that learning science is useful for my future life/career"). To support the existence of a two-factor scale (i.e., general value and utility value), first, we conducted a factor analysis using direct oblimin rotation. The two-factor solution, where three items uniquely loaded together as the utility value factor, explained more variance (75%) than the original one-factor scale (65%). In the subsequent analyses, we used the three-item utility value factor as a measure of utility value, and the entire scale as a measure of value. The reliability of the three-item utility value scale were satisfactory, (time 1: $\alpha = 0.86$; time 2: $\alpha = 0.93$).

Finally, situational interest in course content (e.g., "I think science is an interesting subject") was measured by a five-item scale developed by Hulleman et al. (2010). Items measured students' situational interest in science by eliciting their perceptions on a seven-point scale. The reliability for this scale were satisfactory (time 1: $\alpha = 0.91$; time 2: $\alpha = 0.93$).

For the analyses using LIWC software (Pennebaker et al., 2015), we evaluated the same lexicons used in prior research (Harackiewicz et al., 2016) on utility value interventions: personal pronouns, social processes (e.g., family, friend), cognitive processing (e.g., insight), and personal concerns (e.g., work, leisure). Furthermore, the present study also includes the assessment of an additional lexicon, summary language variables: words per sentence, six-letter words, analytic, clout, authentic, tone.

4.3. Procedures

At the beginning of the science unit, students completed the self-report survey, which included a demographics questionnaire, and assessed self-efficacy, interest, value, and utility value. After eight weeks, students in each class were randomly assigned to a control or treatment condition. In other words, half of the students in each of 8 science classes were randomly assigned to the control condition and the other half were assigned to the experimental condition.

Replicating Hulleman et al.'s (2010) design, students in the control condition were asked to write a summary of what they were learning and to write a summary review of the selected topic (emphasized in the excerpt below):

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

Students in the treatment condition were also asked to pick a topic, but instead of a summary, in order to reflect on real-life connections, they were asked to think about an application of this concept to their lives or the lives of the people around them (also emphasized in the excerpt below):

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 applies to your future plans?* 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. Remember: Do both Part A (pick a topic and summarize) and Part B (apply it to life).

Students completed only one essay as the intervention. The essays were not part of students' course grades and were completed during their science lesson. Students completed the post-test approximately one month after the intervention, at the end of the fall semester.

4.4. Data analysis

The analysis of the student writings for the first research question (i.e., connections to real-life tasks) was done using a rubric created by the members of the research team. The rubric, presented in Table 1, had four levels: 0: no response, 1: generic application, 2: specific application, without explaining how it is connected, and 3: specific application and explaining how it is connected. Once we established the rubric, one of the co-authors and a trained research assistant independently rated 10% of the essays independently. As interpreted using Landis and Koch's (1977) criteria, there was a satisfactory amount of agreement (0.75) between the two researchers in this first independent run, with a Cohen's kappa of 0.67. In cases of disagreement, coders met to discuss codes that differed to calibrate and reach consensus. The research assistant completed the analysis of the remaining responses using the rubric.

The Linguistic Inquiry and Word Count (LIWC) was used to determine if the nature and quantity of the psychological processes elicited in students written reflections differed by condition (Pennebaker et al., 2015). The LIWC is software developed to carry out computational analyses of text data. The LIWC uses a *dictionary-based* approach that consists of comparing the words in text data to dictionaries of words that exemplify an underlying construct, such as the word "enjoyment" being indicative of positive emotions. The LIWC, in particular, is valuable for dictionary-based approaches because it is validated with respect to psychological constructs and it is widely used in education, psychology, and other fields (Tausczik & Pennebaker, 2010).

In order to answer the third and fourth research questions, survey data were analyzed using mixed effects or multi-level models regression in two steps. While we have a small number of classes (eight), multi-level models will perform similarly to regression analyses with dummy codes. Furthermore, as long as the amount of variability explained at the class level is greater than 0%, will perform better, even with a small number of classes (Gelman & Hill, 2007). In the first step, null models with only the classroom variable were included. As a grouping variable, the classroom was treated as a random effect. In the second step, the fixed effects predictors were added, including both main and (in the case of the self-efficacy by intervention) interactive effects. These models

Table 1
Rubric levels and sample student responses from student reflections.

	Level 0	Level 1	Level 2	Level 3
Description	No response, *or* the response does not include anything regarding an application (e.g., just a summary)–	The application is very generic. For example, a job is mentioned, or an application but nothing else is explained.	A specific application or a future career is mentioned but how or why this science topic impacts are not fully explained (e.g., mechanism)	Both a specific application or a future career is mentioned (e.g., a specific job title) and the mechanism as to how this bit of knowledge works and will be related is explained
Sample Student Response	Particles move in the air by getting heated and gaining energy. The particles break off from its form and bump into other molecules and start moving in the air.	this explains why you can smell hot food more than cold food.	you can buy detectors like this so you can be protected from things like carbon monoxide and things like fires and smoke of things that can be harmful to humans.	If I am ever blowing up balloons for a party and I want to keep the balloons big, I will keep them in a warm room so the molecules speed up and spread out, hitting the sides of the balloons and expanding it. In a cold room, the molecules will slow down and come together and the balloons sides will close and become smaller.

Table 2
First-order correlations, minima, maxima, mean, and standard deviations among variables.

	1	2	3	4	5	6
1. Utility Value (T1)	–					
2. Self-efficacy (T1)	0.50*	–				
3. Interest (T1)	0.40*	0.42*	–			
4. Utility Value (T2)	0.46*	0.25*	.32*	–		
5. Interest (T2)	0.32*	0.24*	.49*	.65*	–	
6. Intervention	0.08	0.06	−0.04	0.14	−0.02	–
Minimum	1.33	1.20	1.00	1.00	1.00	0
Maximum	7.00	7.00	7.00	7.00	7.00	1
Mean	5.67	5.35	5.39	5.65	5.39	0.52
Standard Deviation	1.03	1.38	1.55	1.49	1.30	0.50
Skewness	−1.04	−0.82	−1.18	−1.04	−0.89	–
Kurtosis	0.36	0.07	0.09	0.11	0.11	–

* $p < 0.05$.

were specified for each of the three dependent variables: utility value, value, and interest.

5. Results

We first present results from preliminary analyses, followed by results associated with each research question.

5.1. Preliminary analyses

To check whether making reflections led students to write more, the length of the written responses was examined. First, to determine whether the use of multi-level models was warranted, we examined an intercept-only (or null) model, with the word count as the dependent variable the class students were in as the random effect. This model revealed that 6.58% of the variability in word count was attributable to the class students were in, so we proceeded with use of multi-level models for determining whether there were differences between students in the intervention and control conditions. This model revealed that there were no differences (?? = −1.26, $p = 0.796$). First-order correlations, as well as the range, mean, skew, kurtosis, and standard deviations among variables, presented in Table 2, were examined. These descriptive statistics were as expected in terms of the pattern of correlations and variables' ranges and were within acceptable limits for the skew and kurtosis.

5.2. RQ#1: connections in student essays

In order to understand if the relevance intervention led students to make more connections to real-life contexts and applications in their reflections, we conducted a content analysis of the student reflections using our real-life connections rubric. First, to determine whether use of multi-level models was warranted, we examined an intercept-only (or null) model, with the rating from the content analysis (higher scores indicate higher levels of connections to see Table 1) as the dependent variable the class students were in as the random effect. This model revealed that effectively none of the variability in this rating was attributable to the class students were in, so we carried out an independent samples *t*-test for differences in rating on the basis of being in the intervention or control condition. The results of the *t*-test indicated that there was a significant difference between the two groups in terms of ratings of relevance as assessed on the 4-point scale favoring the experimental group, $t(135) = 7.67$, $p < 0.01$; with a Cohen's $d = 1.31$. The treatment ($M = 1.71$, $SD = 0.97$) group's essays included more utility value than the control group ($M = 0.46$, $SD = 0.93$).

5.3. RQ#2: psychological process elicited in student reflections

LIWC analyses indicated that there was not a statistically significant difference between the control and treatment conditions for all of the constructs that were investigated in previous research (i.e., Canning and Harackiewicz, 2015; Harackiewicz et al., 2016), except for cognitive processing (i.e., students' writing involving the use of causation, differentiation, or insight), which was more frequent in responses of students in the intervention group ($\beta = 2.81$, $p = 0.03$, $d = 0.50$). We also examined new summary categories in LIWC 2015 (Analytic, Clout, Authentic, and Tone) and found no statistically significant differences across these. Many of these constructs were not common to students' responses (Table 3), either in treatment or control conditions: For example, Family, Friend, Female, Male, and Leisure comprised less than 1% of the words across all responses.[1]

[1] We also tested word count and cognitive processing by self-efficacy interactions, because greater number of words or higher cognitive processing may indicate enhanced impacts of the intervention that may interact with students' self-efficacy in important ways (and because other results indicated cognitive processing differed significantly between intervention and control group students). However, neither interaction approached statistical significance for any of the dependent variables, so we excluded these from the analysis.

Table 3
Results from Linguistic Inquiry and Word Count (2015) Analysis.

	Percentage of Words in Control Group Responses	Difference (in Percentage) in Words for Students in Intervention Condition	ICC	Cohen's *d*
Personal pronouns	5.32	1.60 (.71)$^{+}$	0.00	0.37
Social Processes	4.45	−0.04 (0.73)	0.00	NA
Family	0.01	0.15 (.08)$^{+}$	0.00	1.42
Friend	0.18	−0.13 (.08)$^{+}$	0.03	0.21
Female	0.03	0.08 (.08)	0.01	NA
Male	0.00	0.09 (0.09)	0.03	NA
Cognitive Processing	9.27	2.81 (1.00)*	0.11	0.50
Insight	1.63	1.00 (0.38)$^{+}$	0.05	0.55
Cause	2.89	0.55 (0.46)	0.01	NA
Personal Concerns				
Work-School	1.15	0.91 (0.47)	0.08	NA
Leisure	0.31	−0.02 (0.19)	0.13	NA
Summary Language				
Analytic	65.71	−7.15 (4.81)	0.01	NA
Clout	50.80	−7.46 (4.53)	0.02	NA
Authentic	66.74	−0.47 (5.58)	0.00	NA
Tone	38.41	3.77 (4.66)	0.01	NA
Six-letter words	17.20	−0.48 (1.07)	0.02	NA
Words per sentence	14.56	1.01 (1.02)	0.01	NA

$^{**}p < 0.01$.
$^{***}p < 0.001$
$^{+}$ $p < 0.10$.

5.4. RQ#3: effects of relevance intervention on perceived utility value and interest

Regression coefficients, intraclass correlations (ICCs), R^2 values, and the number of missing cases (listwise deletion was used for all models) for the multilevel modeling analysis are reported in Table 4. The ICCs for the null model for Time 2 utility value was 0.03, for Time 2 general value was 0.06, and for Time 2 interest was 0.15. As expected, the intervention predicted a positive increase in Time 2 utility value ($\beta = 0.44$, $p = 0.041$, $d = 0.29$). While the intervention was associated with an increase in students Time 2 utility value, it was not, associated with an impact on students' Time 2 general value ($\beta = 0.32$, $p = 0.08$, $d = 0.24$) nor interest ($\beta = 0.02$, $p = 0.90$, $d = 0.02$). In other words, the utility value intervention impacted students' utility value perceptions but not their interest. The R^2 for the models ranged from 0.29 to 0.37. The ICCs for the models ranged from 0.03 to 0.15.

5.5. RQ#4: moderating effect of self-Efficacy

To understand if self-efficacy moderated the effects of the intervention on students' interest and value, we added a Time 1 self-efficacy by treatment interaction in a second step to the models used for the previous research question. As reported in Table 4, the interaction was not statistically significant for the models predicting Time 2 utility value ($\beta = 0.24$, $p = 0.21$) nor value ($\beta = 0.12$, $p = 0.17$) and interest ($\beta = 0.30$, $p = 0.20$). In other words, self-efficacy did not moderate the effects of the intervention unlike

Table 4
Output from multilevel models for utility value, value, and interest.

	Time 2 Utility Value	Time 2 Value	Time 2 Interest
Fixed Parts			
Intercept	5.52	5.51	5.49
Time 1 Self-efficacy	−0.19 (0.15)	−0.19 (0.13)	−0.15 (0.15)
Time 1 Interest	0.24 (0.09)*	0.19 (0.08)*	0.42 (0.10)*
Time 1 Utility Value	0.43 (.08)***	0.46 (0.10)*	0.29 (0.12)*
Intervention	0.44 (0.20)*	0.32 (0.17)	0.02 (0.20)
Self-efficacy X Treatment	0.24 (.209)	0.12 (0.17)	0.30 (0.20)
Gender	−0.22 (0.20)	−0.02 (0.17)	−0.30 (0.20)
Random Parts			
Classroom??^{2}	1.73	1.23	1.67
Classroom ICC	0.03	0.07	0.15
R^2	0.29	0.34	0.37
Missing	42	35	35

$^{**}p < 0.01$.
* $p < 0.05$.
*** $p < 0.001$.

previous studies (e.g., Hulleman et al., 2010).

6. Discussion

We carried out a field experiment on the effectiveness of a specific type of social psychological intervention targeted to enhance students' utility value and interest with fifth and sixth-grade students in science. Because of the scarcity of research on the impacts of utility value interventions among younger students (Lazowski & Hulleman, 2016), we also examined both the fidelity of the intervention as well as the psychological processes elicited in students' responses. Consistent with prior research (e.g., Hulleman & Harackiewicz, 2009; Hulleman et al., 2010), the utility value intervention administered once in a semester was associated with increases in students' utility value for science. This result extends prior research by demonstrating that this brief social-psychological intervention can also be beneficial for younger students. Notably, in contrast to prior research, this intervention did not impact students' interest, and self-efficacy was not a moderator of its effectiveness in our context. There are numerous possible explanations for this pattern of results.

The first, and perhaps most critical explanation for these results is that despite exhibiting an increase in utility value, this demographic group (i.e., fifth- and sixth-grade students) may not have engaged in the intervention in the same way as the more commonly studied demographic groups (i.e., high school and undergraduate students). Since this was a particularly relevant concern when attempting to generalize a self-generated utility value intervention to this younger demographic group, special care was taken to investigate the fidelity of the treatment and the underlying processes that students engaged in while interacting with the intervention content. Encouragingly, results from the manual qualitative coding of students' writing provide evidence that is similar to the results with older students (e.g., Canning & Harackiewicz, 2015; Hulleman et al., 2010): younger students generated the desired utility value ideas and thus followed the instructions conscientiously. Furthermore, according to the text mining analyses (i.e., the LIWC), students in the experimental group engaged in more cognitive processing, which suggests that engaging with the intervention content was not a passive activity, but rather yielded the desired active participation hypothesized to be a key mechanism of the delivery of this type of brief intervention (see Yeager & Walton, 2011). It should be also noted that for "personal pronouns", "family", "friend", and "insight" the difference between the two conditions was sizable as indicated by medium to large effect sizes (Table 3). The results of the LIWC suggest that the intervention led to more cognitive processing. This finding confirms Harackiewicz et al.'s (2016) findings in that the utility value intervention leads to more cognitive processing as reflected by the number of words signaling active thinking and reflecting (Pennebaker & King, 1999). As indicated by the sizable effect sizes, the student writings in the treatment condition had significantly more personal pronouns or family-related words than the control condition. This is not surprising because the prompt in the treatment condition directly mentioned "helping a friend or family member", but nonetheless, shows that students understood and followed the writing prompts. Beyond its immediate interpretation, it should be also noted that these findings also speak to the fidelity of the treatment, in that this age group was able to process and respond to this task that was only used in older learner contexts previously. It should also be noted that the length of the student essays as well as the students' writing style in terms of analytical thinking, clout, authenticity, and emotional tone in both conditions were similar. This finding differs from the findings of similar research studies conducted in adult learner settings, where the intervention led to increased student writing (e.g., Hulleman & Barron, 2017). In this study, we directly replicated the writing prompts from the early research. It is possible that the writing prompts may be tweaked to become more age-appropriate to encourage more writing, but, regardless of length, through our rubric and content analysis, we were able to capture the difference in student essays.

The second explanation for some of the contrasting findings relates to the high level of interest reported in this sample at Time 1 ($M = 5.39$ on a 7-point Likert scale). Although this ceiling effect makes it especially difficult to further increase students' interest with an intervention, the high level of interest reported in the present study corresponds to levels of interest reported in prior research (e.g., Lepper et al., 2005). In fact, according to Lepper et al. (2005), there is a linear decrease in intrinsic motivation[2] from grade three to grade eight. These results can be interpreted in two ways. One interpretation would be that high levels of interest in younger students may suggest that this demographic group does not yet need an intervention to increase their interest, and therefore a utility value intervention should be reserved for older students whose interest has already begun to waver. Alternatively, researchers and practitioners may argue that in light of the forecasted decline in intrinsic motivation, an early intervention could be especially useful for bolstering interest before the projected decline. The question of whether a utility value intervention will promote a more durable form of interest for these students cannot be answered in the present study, but future research can investigate this question by tracking the longitudinal development of interest in science among students who have received a utility value intervention. It is also possible that, through underlying recursive processes, this type of intervention may prevent a potential decline in students' interest in science, by helping them reflect on the personal relevance of the learning content.

A third explanation for this pattern of results, in particular why self-efficacy did not moderate the effects of the intervention on interest and utility value relates to the specificity of the measure of the competence related belief assessed in the present study. Prior research has found evidence that the effects of utility value interventions are moderated by performance expectations (e.g., Hulleman et al., 2010) or perceived competence (e.g., Durik et al., 2015), however, in this study, students' self-efficacy was assessed. Although all three of these measures are conceptually similar in terms of assessing perceptions of capabilities, they represent slightly different constructs. The primary difference between these measures is that self-efficacy represents a more task- and situation-specific measure than performance expectations (Pajares, 1996). As such, prior to recommending that grade five and six students' competence beliefs

[2] According to Lepper et al. (2005), intrinsic motivation can more generally be viewed as a measure of interest.

are not moderators of the effectiveness of self-generated utility value interventions, a more systematic comparison of different measures and conceptualizations of these constructs in this context is necessary.

A fourth explanation concerns the amount of variability at the classroom level for each of the three outcomes. While the classroom-level ICC for Time 2 utility value and value were low (for both the null models and the models with the predictor variables, or the full model), they were higher for interest (.15 for both the null and full models for interest compared to between 0.03 and 0.07 for both the null and full models for utility value and value). This could suggest that interest is impacted more by classroom-level factors, such as characteristics of the teacher, than utility value, which may be impacted more by student-level factors. Accordingly, because the intervention operated at the student-level, value may be more responsive to interventions than interest.

A final explanation for the difference in results reported in this study and prior work (i.e., the lack of effect on interest, and self-efficacy not being a moderator) is that the intervention works differently for younger students than with older students. As previously discussed, the utility value intervention may not have led to an increase in interest with this younger sample because their interest was already quite high. Furthermore, it is possible that students' perceptions of their competence are less well formed or stable at this younger age in comparison to older children, which would explain the lack of moderation found in the present study (see Wigfield et al., 1997). Although this is also a plausible explanation for the results presented, based on the fidelity of the treatment, the deep processing elicited, and the effect on value, the results provide initial support for the effectiveness of a utility value intervention with grade five and six students. Nevertheless, since this is the first study to investigate the effectiveness and suitability of this type of intervention with a younger demographic group, further research is needed to replicate these results and determine if age or grade level are in fact moderators of the effects of utility value interventions.

7. Limitations of the study and directions for future research

The results presented in this study provide an encouraging extension of the current work on utility value interventions but naturally, there are a few limitations that must be acknowledged. The effects of the intervention on utility value—while in-line with findings from past research—were modest, and the predicted impact on interest was not found, the results of this study should be interrogated and replicated through future research. Given the myriad of factors impacting students' value of science social psychological interventions such as that explored in this study should not be considered to be silver bullets or the answer to all motivation- and achievement-related educational concerns (Yeager & Walton, 2011). Another limitation of this study was that self-efficacy, rather than perceived competence or performance expectations, was assessed. This measure represents a deviation from prior approaches used and may have resulted in a lack of replication for the moderation analyses. Consequently, future researchers need to take great care when designing extension or replication studies, even extend this inquiry further to allow for direct comparisons of self-efficacy and perceived competence by measuring. Another limitation of this study is that it was conducted in only eight classes with four teachers. Although the treatment and control conditions were randomly assigned within each science teacher's class, and analyses suggest that these contextual differences were negligible (see Preliminary analyses), a larger number of classes with more teachers would have permitted a more powerful analysis of the potentially nested structure of the data. Also, it should be noted that the units (and the school context) for this study were reform-based, facilitating students' understanding of scientific concepts within real-life contexts. Therefore, there may be an interaction between the interaction and the learning context. Although it should be noted that all students in the current study received the same unit, and they were assigned to the treatment and control conditions through randomization. Finally, it should be noted that the rubric analyses is more subjective, despite our efforts to establish reliability. In future studies, more robust methods can be implemented to increase interrater reliability.

8. Conclusion

The purpose of this study was to investigate the effectiveness and suitability of using a self-generated utility value intervention with students in fifth- and sixth-grade science courses. Results provide initial evidence that the intervention was applied appropriately, and that the intervention was effective for increasing students' utility value for science. Specifically, the intervention enhanced students' value for science with an effect size of 0.31, evidence in support of a small- to medium-sized effect. The outcomes from this research are in line with or slightly larger than that reported in findings from prior research; Hulleman et al. (2010) reported effects of 0.19 standard deviation and 0.08 standard deviations across the two studies they reported. These initial results represent an important extension of the current work on utility value interventions by targeting a sensitive period where students begin to pursue science-related classes and careers (Hidi & Harackiewicz, 2000), and potentially initiating the recursive benefits hypothesized to explain the benefits of brief social psychological interventions (Walton & Yeager, 2011). In addition to the effectiveness of this intervention, it is also low-cost and convenient to integrate into existing courses and curricula. Although these results are promising, prior to scaling up the application of utility value interventions with younger students, further research should investigate potential moderators and the long-term effects of the intervention by conducting longitudinal studies with a diverse sample of students. As scholars continue to examine how to enhance students' motivation through educational reform and targeted interventions, their design and efficacy among younger students must continue as an area in need of study. The present research contributes to this initial understanding.

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