The Effect of Utility Messages During Science Instruction on Students’ Perceptions of Task Value

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Abstract

Using data collected through surveys, classroom observations, and a variant of Experience Sampling Method, we investigated whether the use of utility value statements during science instruction is related to seventh grade students’ perceptions about the usefulness and importance of their daily science activities. We also examined whether gender, race, interest, grades and perceived competence moderate these relationships. Hierarchical Linear Modeling revealed that the number of utility statements made during instruction was positively associated with students’ ratings of usefulness and importance of the content. Students with high perceived competence expressed greater valuing of science content. Gender and race played a complex role in the relationship between teacher statements and students’ beliefs. Implications for motivation research and science teacher practice are discussed.
The Effect of Utility Messages During Science Instruction on Students’ Perceptions of Task Value

The purpose of this study is two-fold. First, we investigate whether emphasizing the utility of science content is related to seventh grade students’ perceptions of the usefulness and importance of science tasks, while also taking into account students’ interest in these tasks. Second, we examine whether these relationships are moderated by factors like gender, race and perceived competence, while controlling for students’ science grades.

Science class can be challenging for students; learning science often requires that students be actively engaged in learning. The expectancy-value model (Eccles et al., 1983) identifies student beliefs about the subjective value of tasks as an important factor in their engagement and motivation. Subjective task values are defined as how a task might meet different needs of students. Students may find tasks valuable for a wide range of reasons. For example, research has shown that high school students see science as more valuable than middle school students which is largely due to the belief that doing well in science class is important for college admissions (Baker & Leary, 1995; Greenfield, 1996). Research has also shown that student perceptions of high value in their schoolwork supports achievement-related behaviors in their lives outside of school. For example, students who do not find their schoolwork useful, do not tend to associate their academic behaviors with their personal lives, whereas students who find their schoolwork useful tend to find their academic behaviors beneficial for their lives (Simons, DeWitte, & Lens, 2004). The extent to which students perceive value in their academic coursework has been shown to impact students’ decisions to pursue those domains in both the short-term and long-term (i.e., Durik, Vida, & Eccles, 2006).
In this study we focus on three components of students’ task value beliefs in science class (Eccles & Wigfield, 1995): usefulness of the task outside of school, the personal importance of the task, and students’ interest in the task. While these components have been shown to be positively and moderately correlated, research has provided empirical support to the theoretical distinctions between these three components of task value (e.g., Eccles & Wigfield, 1995).

At the same time, research has also shown that competence beliefs are important in successful performance in various domains (Bandura, 1997; Csikszentmihalyi, 1990; Eccles et al., 1998; Meece et al., 1990; Wigfield & Eccles, 1992). Students who feel competent in a certain domain, however may not choose to engage in that domain if they find no value in it (Wigfield & Eccles, 2002). Competence and task value beliefs, then, complement each other in determining students’ task choice and engagement. Given the importance of considering competence beliefs in relation to students’ task value beliefs, in this study we investigated whether students who feel they are good at science will be more likely to see it as useful and important to them. Additionally, we examine whether those with high competence beliefs are more likely to internalize statements made during instruction about the utility of science.

There is evidence that adolescent boys and girls differ in their perceptions of the value of science. For example, middle school girls were found to report that science has less value than do boys (Catsambis, 1995; Lee & Burkam, 1996), and utility beliefs as well as ability beliefs played an important role in 7th and 9th grade girls’ course-taking (James, 2002). It has been well documented that Hispanic students have lower achievement in STEM courses, and Hispanic adults are severely underrepresented in STEM fields compared to non-Hispanic Whites (Taningco et al., 2008). There could be ethnic differences in students’ perceptions of the value for science that may help explain observed ethnicity gaps in STEM areas. Consequently Hispanic
students may draw particular benefit from instructional approaches that involve the use of utility statements in classroom. In light of race and gender differences in perceived task value in the science classroom, in the present study we investigate whether the relationship between the use of utility statements in class and students’ perception of the usefulness of and importance of science is moderated by race and gender. The research questions that guide this study are:

1-What is the association of utility statements and students' interest during science instruction with students’ perceptions of the usefulness and importance of science tasks?

2-How do the associations tested in question 1 vary by gender, race, and perceived competence, while controlling for grades?

**Method**

Data used in this paper were collected as part of a larger, federally-funded study designed to examine classroom factors that impact students’ interest, engagement and achievement in science. Data were collected in 2011-2012 from two middle schools (n=14 classrooms) serving students from a diverse community located on the fringe of a large metropolitan area.

**Participants**

**Student Sample.** Three hundred and seventy-nine 7th grade students participated in the study (mean age=12.24). The sample was 45% male and 55% female. The sample was 57% Hispanic (regardless of race), 22% non-Hispanic White, 8% multi-racial (non-Hispanic), 11% African American, 3% Asian, and less than 1% Native American. According to school records, 61% of the participants were eligible to receive free or reduced lunch. Forty-four percent of the students in the sample reported that neither of their parents had attained a college degree. Twelve percent said that at least 1 parent had graduated from college, and 11% indicated that at least one parent had earned an advanced degree.
Teacher Sample. The 7th grade teacher sample was comprised of four White females; two in their twenties and two in their fifties. They had between four and 20 years of teaching experience, with the vast majority of each teacher’s experience being in their present school. The two older teachers had each taught briefly in another school. The two older teachers were tenured; the two younger were not. Both of the older teachers had earned master’s degrees. For each teacher, we observed in either 3 or 4 of their 7th grade science classrooms.

Instruments and Measures

Data were collected using traditional surveys, classroom observations, and a variant of the Experience Sampling Method (ESM, Csikszentmihalyi & Larson, 1987). Each classroom was observed 11 times during the school year by at least 2 trained observers. Following each observed lesson, students completed an Experience Sampling Form (ESF) in which they were prompted to “think about their work in class today” and report on several dimensions of their experience using 4–point Likert scales. The ESFs took approximately 3 minutes to complete.

Turner and colleagues have used procedures very similar to those used in the current study, combining ESM and observational data to demonstrate relationships among specific instructional practices and students’ subjective experience (Turner, et al., 1998; Schweinle, Turner & Meyer, 2006). The method has a high degree of external or “ecological” validity, capturing participants’ responses in everyday life. There are indications that the internal validity of the ESM is stronger than one-time questionnaires as well. Zuzanek (1999) has shown that the immediacy of the questions reduces the potential for failure of recall and the tendency to choose responses on the basis of social desirability (see Csikszentmihalyi & Larson, 1987, and Hektner, Schmidt, & Csikszentmihalyi, 2007 for extensive evidence on ESM’s validity and reliability)

Outcome Measures. Perceived usefulness was measured on the ESM form. Students
were asked to rate whether they “think what you learned today could be useful outside of school?” (-1=no, 22%; 0=not sure, 33%, and 1= yes, 45%, M=0.23, SD= 0.788). *Perceived importance* was also measured on the ESM form. Students were asked to rate the importance of “today's work to you?” (0=not at all, 3=very much; M=1.85, SD=1.063).

**Time-varying Predictors.** *The number of utility statements made during science instruction* was gathered from classroom observations. Two to three trained observers conducted classroom observations and recorded instances during the class which pertained to any type of value statement that was made about science (utility, attainment, intrinsic, cost values). The initiator (i.e., teacher, student) of the utility statement was also noted. In the current paper, we focused on any utility value statement made by either teachers or students to capture the full range of utility statements that the students were exposed to. Statements were coded as referencing utility value if the speaker pointed out how what the class was doing or learning related to everyday life (e.g., “it’s important to understand acceleration when you drive a car”), to students’ future educational plans (e.g., “this will help you understand chemistry when you get to high school”), to students’ occupational plans (e.g., “you said you wanted to be an engineer: engineers use this all the time”), or to careers in general (e.g., “Dieticians use their knowledge of food chemistry to help people learn how to eat right.”). Utility value statements were coded on multiple dimensions, but for the purpose of this study we focused simply on the number of times these statements were made in each class period. This way, the total number of utility value statements made in class can be matched to students’ ratings of the perceived usefulness of the content they covered in class that day. A total of 287 utility statements were recorded during the observations, with 77% of those being made by the teacher and 23% by students.

*Situational Interest* was another time-varying predictor of the two outcomes, and was
measured on the ESM form. Students were asked to rate the extent to which they thought today’s class work was interesting. (0=not at all, 3=very much; M=1.70, SD=1.076).

**Time-invariant Predictors.** Perceived competence was measured in a survey administered to students prior to the classroom observation period. In the survey students rated these three items (from Wigfield & Eccles, 2000) about their science ability: How good in science are you? (1=not at all good, 7=very good), If you were to list all the students in this class from the worst to the best in science, where would you put yourself? 1=one of the worst, 4= in the middle, 7=one of the best), and Compared to most of your other school subjects, how good are you in science? (1=a lot worse in science, 4=about the same, 7=a lot better in science). These ratings were combined to create a composite variable of perceived competence (M=4.26, SD=1.22, \(\alpha=.80\)).

**Gender, Ethnicity and Grades.** Students reported their gender and ethnicity in surveys. Students’ first quarter science grades were gathered from school records and were used as a control in analysis (0=F, 1=D, 2=C, 3=B, 4=A, M=2.67, SD=1.17).

**Analyses**

Because the data are nested (ESM observations nested within students) Hierarchical Linear Modeling (HLM, Raudenbush & Bryk, 2002) was used to analyze the data. The aggregated measures of students’ perceived usefulness and importance were used as outcome variables. The number of utility statements made during science instruction and students’ perceived interest were included as time varying level-1 variables. Gender (female=1, male=0), ethnicity (Hispanic, regardless of race=1, non-Hispanic=0) and students’ ratings of perceived competence were included at level-2. Students’ science grades were entered as a control variable. Analyses explored interactions between ethnicity and gender as well. As an illustration of the
models used in our analyses, we present the level 1 and level 2 equations built for the Usefulness outcome.

**Level-1 Model**

\[
Usefulness_{ti} = \pi_{0i} + \pi_{1i} \text{(Number of Utility Statements}_i) + \pi_{1i} \text{(Interest}_i + e_{ti}
\]

**Level-2 Model**

\[
\pi_{0i} = \beta_{00} + \beta_{01}(Female_i) + \beta_{02}(Competence_i) + \beta_{03}(Hispanic_i) + \beta_{04}(Hispanic*Female_i) + \beta_{05}(Grades_i) + r_{0i}
\]

\[
\pi_{1i} = \beta_{10} + \beta_{11}(Female_i) + \beta_{12}(Competence_i) + \beta_{13}(Hispanic_i) + \beta_{14}(Hispanic*Female_i) + \beta_{15}(Grades_i) + r_{1i}
\]

\[
\pi_{2i} = \beta_{20} + \beta_{21}(Female_i) + \beta_{22}(Competence_i) + \beta_{23}(Hispanic_i) + \beta_{24}(Hispanic*Female_i) + \beta_{25}(Grades_i) + r_{2i}
\]

**Results**

**The Effect of Utility Statements and Interest on Task Usefulness**

As seen in Table 1, regardless of gender, ethnicity and science achievement, average student usefulness ratings indicate that in general students were “not sure” whether the day’s content was useful ($\beta_{00} = 0.17$ $p<.05$). There was, however, variation in perceived usefulness that can be attributed to perceived competence. Students with higher perceived competence tended to rate the science topic as more useful ($\beta_{02} = 0.09$, $p <.05$).

The number of utility statements made during instruction was positively associated with non-Hispanic males’ ratings of usefulness of the content for that day ($\beta_{10} = 0.062002$, $p<.001$), such that for every utility statement made, non-Hispanic males’ ratings of usefulness increased by .06. Non-Hispanic females did not differ significantly from non-Hispanic males in this relationship, suggesting that the relationship between utility statements and usefulness ratings
were similar across these two groups ($\beta_{11} = -0.02$, p=ns). While the positive effect of utility statements on usefulness ratings was weaker for Hispanic males ($\beta_{13} = -0.07$), it was stronger for Hispanic females ($\beta_{14} = 0.06$, marginal significance), such that for every utility statement made, Hispanic females’ ratings of usefulness increased by .12 (.06 + .06). Students’ competence beliefs and science grades did not play a significant role on the positive effect of utility statements on perceived usefulness.

Higher ratings of interest during science instruction was associated with higher ratings of usefulness of the content for that day ($\beta_{20} = 0.18$, p<.001) for all students regardless of gender, ethnicity and competence beliefs. This positive relationship was stronger for students with higher levels of science achievement ($\beta_{25} = 0.03$, p<.05).

**The Effect of Utility Statements and Interest on Task Importance**

As seen in Table 2, regardless of gender and ethnicity, average student usefulness ratings indicate that in general students thought that the day’s content was “somewhat” important ($\beta_{00} = 1.79$, p<.001). As with the task usefulness outcome, there was variation in task importance that can be attributed to perceived competence. Students with higher perceived competence tended to rate the science topic as more important ($\beta_{02} = 0.06$, p=.05). Higher science achievement was related to lower ratings of importance ($\beta_{05} = -0.07$, p<.05).

The number of utility statements made during instruction was positively associated with non-Hispanic males’ ratings of task importance ($\beta_{10} = 0.04$, p<.05), such that for every utility statement made, non-Hispanic males’ ratings of the importance of the content for that day increased by .036. This relationship was weaker for non-Hispanic females ($\beta_{11} = -0.06$, p<.05), and Hispanic males ($\beta_{13} = -0.07$, p<.01). This suggests that in comparison to non-Hispanic male
students, non-Hispanic female and Hispanic male students would need more frequent exposure
to utility statements in class in order to find their class content more important.

The positive effect of utility statements on importance ratings was remarkably stronger
for Hispanic females ($\beta_{14} = 0.12, p<.001$) than any other group of students, such that for every
utility statement made, Hispanic females’ ratings of the importance of the content for that day
increased by .15 ($0.03 + 0.12$).

Higher ratings of interest during science instruction were associated with higher ratings
of importance of the content for that day ($\beta_{20} = 0.39, p<.001$) for all students regardless of
gender, ethnicity, competence beliefs or science achievement.

**Discussion**

Results of this study contribute to motivation research and science teacher practice in
several ways. Results suggest that when teachers emphasize the utility of science content during
instruction, this does become internalized by students and is reflected in their own perceptions of
the usefulness and importance of that content. As finding value in an activity is critical to
persistence in that activity, this teacher behavior could have important implications for students’
achievement and persistence in science.

Our results also emphasize the crucial role of students’ ability beliefs in finding science
content useful in that students with high ability beliefs expressed higher usefulness and
importance of the science content. On the other hand, competence was not a significant
moderator of the positive relationship between the use of utility statements during science
instruction and students’ ratings of task usefulness and importance. This suggests that even
students with low competence beliefs benefit from the positive effects of emphasizing the utility
of science content during instruction.
Results suggest that gender and ethnicity play a complex role in moderating the relationship between utility statements and students’ task value beliefs. Emphasizing the utility of science content during instruction had the strongest positive impact on Hispanic females’ beliefs about task usefulness and importance. The second strongest impact of utility statements on positive task value beliefs was for non-Hispanic males. This suggested that in order to positively influence the task value beliefs of the other two groups of students, non-Hispanic females and Hispanic males, teachers would need to highlight the utility of science content more frequently.

Results also provided evidence that emphasizing utility of science during instruction had positive effects on task value beliefs, regardless of students’ interest in the class content. The same independent effect was observed for interest, such that students’ interest in the science content was positively reflected in their ratings of usefulness and importance, regardless of whether or not utility messages were made in class. This suggests that emphasizing the utility of science and supporting students’ interest in tasks can both promote positive task values independently of one another. Therefore, science instruction may benefit from both of these teacher behaviors. Recent multi-method research in science classrooms suggests that teachers miss many opportunities to emphasize the value of science to students in the course of everyday science instruction. Teachers may erroneously assume that their students are independently making more frequent connections between science content and their lives, or teachers may lack the deep content knowledge that is necessary to make spontaneous connections during instruction. Moreover, this same research suggests that students report relatively low levels of interest during science instruction (Shumow & Schmidt, 2014). Thus, these are two areas that are very promising for improving the value students place on science.
A finding that merits further investigation was that higher science grades were related to lower ratings of task importance. There was a moderate correlation between competence and science grades ($r=0.42$) indicating that there was no multicollinearity between the two measures. A possible explanation is that students may have interpreted task importance as having high stakes for future education (e.g., I need to do well in this course), and thus students who are already doing well in class may have felt less pressure to do well and therefore may have reported lower importance ratings.
References


Hulleman, C. S., Godes, O., Hendricks, B. L., & Harackiewicz, J. M. (2010). Enhancing interest and performance with a utility value intervention. *Journal of Educational Psychology,*


## Tables

Table 1. Two-level Hierarchical Linear Model Analysis Predicting Usefulness

<table>
<thead>
<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>t-ratio</th>
<th>d.f.</th>
<th>p-value</th>
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<tbody>
<tr>
<td>For Intercept1, $\pi_0$</td>
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<td></td>
<td></td>
<td></td>
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<tr>
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<td>For Utility Messages slope, $\pi_1$</td>
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</table>

**Notes:** N= 276 Level-1 units (students), 2402 Level-2 units (responses)
Table 2. Two-level Hierarchical Linear Model Analysis Predicting Task Importance

<table>
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<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
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<th>Approx. d.f.</th>
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<td>1.077</td>
<td>270</td>
<td>0.282</td>
</tr>
<tr>
<td>Hispanic*Female, $\beta_{24}$</td>
<td>-0.118952</td>
<td>0.090341</td>
<td>-1.317</td>
<td>270</td>
<td>0.189</td>
</tr>
<tr>
<td>Science Grades, $\beta_{25}$</td>
<td>-0.022321</td>
<td>0.022633</td>
<td>-0.986</td>
<td>270</td>
<td>0.325</td>
</tr>
</tbody>
</table>

Notes: N= 276 Level-1 units (students), 2402 Level-2 units (responses)