Expectancy-value antecedents and cognitive consequences of students' emotions in mathematics
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Chapter 5

Expectancy-Value Beliefs and Emotions: A Cross-Lagged Longitudinal Analysis\(^7\)

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Abstract

The present study examined the reciprocal relationships between expectancy-value beliefs (competence beliefs, intrinsic value, attainment value and utility value) and four academic emotions (anxiety, boredom, enjoyment and pride) in mathematics, based on the reciprocal causation assumptions of Pekrun’s (2006) control-value theory of achievement emotions. A sample of 497 grade 7 students (51% girls) completed self-report measures assessing expectancy-value beliefs and emotions three times in a school year. Structural equation modeling was used to test fifteen cross-lagged panel models of reciprocal effects between the beliefs and the emotions. Among these, five models exhibited consistent reciprocal effects (i.e. competence beliefs-anxiety, intrinsic value-boredom, attainment value-pride, utility value-anxiety and utility value-pride). In nine of the models tested, prior emotions predicted subsequent beliefs but not vice versa (e.g., prior enjoyment predicted subsequent expectancy and value beliefs). In one of the models, intrinsic value predicted subsequent anxiety but not vice versa. Implications of these findings for theory and practice are discussed.
Why do some students enjoy math while others dread having to do it? In line with cognitive appraisal theories of emotion in social psychology (e.g., Frijda, 1986; Lazarus, 1991; 2001; Roseman, 2001; Scherer, 2001; Lewis, 2008), emerging theoretical models of emotions in education suggest that students’ emotions arise from self and task related appraisals. In particular, students’ appraisals of their ability in dealing with academic activities and outcomes (e.g., Can I do math?) and their appraisals of the value of these activities and outcomes (e.g., Why should I do math?) have been given much attention in such models (see Boekaerts, 1993; 2007; Pekrun, 2000; 2006; Turner & Waugh, 2007). One important issue that hinges on the role of cognitive appraisals in shaping an individual’s emotions, however, is that of ‘the chicken or the egg’ causality dilemma observed in most of the social sciences. Most appraisal theories of emotion posit appraisals as causes of emotions; nevertheless, research on the cognitive functions of emotions suggests that the appraisal-emotion relationships could be bidirectional (Lewis, 2001). More specifically, research on the cognitive consequences of emotions shows that emotions influence a number of cognitive processes, including perception, memory and evaluative judgments (see Eich & Forgas, 2003; Isen, 2004), all of which have important implications for cognitive appraisals. On the basis of such evidence, several psychologists (e.g., Frijda, 1993; Lewis; 2005; Parkinson, 1997) argue that appraisals are as much the cause of emotions as they are the consequences, implying a reciprocal relationship. Similarly, the emerging models of emotions in education (e.g., Pekrun, 2000; 2006; Turner & Waugh, 2007) emphasize the reciprocal dynamics between appraisals and emotions. In particular, Pekrun’s (2006) control-value theory of achievement emotions proposes that control (expectancy) related appraisals (e.g., competence beliefs, attributions) and value related appraisals (e.g., intrinsic value, achievement goals), and emotions are reciprocally related. Indeed, a handful of studies have documented substantial concurrent relations between expectancy-value related appraisals and emotions (e.g., Boekaerts, 2007; Pekrun, 2000;2006; Goetz, Pekrun, Hall & Haag, 2006; Frenzel, Pekrun, & Goetz, 2006; Turner & Schallert, 2001). However, the temporal relations between the expectancy-value appraisals and emotions, particularly that of reciprocal relations remains unclear. Knowledge of the reciprocal relations between appraisals and emotions is very important for both theory and practice. An understanding of the causal directions of appraisals and emotions helps in
refining existing theories as well as in designing interventions. The purpose of the current study was to examine the reciprocal associations between expectancy-value beliefs and four academic emotions (anxiety, boredom, enjoyment and pride) in the context of school mathematics. In the next sections, we will review relevant literature on the associations between the two groups of variables.

**The ‘Effect’ of Expectancy-Value Beliefs on Emotions**

As noted above, contemporary research and theory on the antecedents of emotions in academic settings have generally emphasized the role of expectancy and value related beliefs. Indeed, most of the studies that examined expectancy-value beliefs as determinants of emotions in academic settings have concentrated on the role of competence beliefs and subjective task values. One may wonder why competence and value beliefs should determine emotional experiences. Bandura (1997) argues that self-competence beliefs influence emotional experiences because they create bias in the construal of events as benign or harmful. Competence beliefs also imply a sense of control over events or situations (Bandura, 1997; Pekrun, 2006). Thus, people with a higher sense of self-competence may tend to see their environment as benign whereas those with a lower self-competence may evaluate the same environment as a threat. Such cognitive appraisals may in turn lead to the experience of emotions (see Lazarus, 1991). Whereas competence beliefs imply the potential for control over the environment, value beliefs imply cognitive evaluation of the significance of a situation for the individual. Whether the situation is appraised as having an intrinsic or instrumental significance, therefore, plays an important role in emotion elicitation. Indeed, appraisal theories (e.g., Frijda, 1986; Lazarus, 2001) generally highlight the cognitive evaluation of the subjective significance of an encounter as a primary appraisal dimension for emotion to occur. In the context of education, such judgments have been studied as value appraisals (see Pekrun, 2006). At least three types of value appraisal have been identified in the literature: attainment value, intrinsic value and utility value (Wigfield & Eccles, 2000). Attainment value refers to the importance students attach to tasks as it relates to the conception of their present or future identity. This value component reflects a student’s evaluation of tasks in terms of his or her self-image (Wigfield & Eccles, 2000). Intrinsic value
is an individual’s evaluation of the attractiveness of the task (Pekrun, 2006; Wigfield & Eccles, 2000). It is similar to interest (e.g., Krapp, 2002) or intrinsic motivation (Ryan & Deci, 2000). Finally, utility value refers to an individual’s judgment of the usefulness of a task (Pekrun, 2006; Wigfield & Eccles, 2000). This value component is similar to instrumental goals (Husman & Lens, 1999).

Several cross-sectional studies have provided insight into the relationship between students’ competence and value-related beliefs and their emotional experiences. Drawing upon a general expectancy-value framework, Turner and Schallert (2001) assessed several expectancy-value-related variables (e.g., self-efficacy, intrinsic goal orientation, task value) among 84 undergraduates and examined whether these variables predicted shame reactions following midterm exam feedback on a supposedly difficult course. Among others, these researchers found that self-efficacy, but not task value, was negatively associated with shame reactions at test feedback even when the feedback was not indicative of an objective failure.

A recent study by Frenzel, Pekrun, and Goetz (2007) found that students’ competence beliefs in mathematics were positively related to enjoyment and pride but were negatively related to anxiety, hopelessness, and shame. Similarly, intrinsic value of mathematics was positively related to enjoyment and pride but was negatively related to anxiety and hopelessness. Extrinsic value, a construct akin to utility value in the current study, was positively related to anxiety, hopelessness, pride, and shame, but was not significantly related to enjoyment. Goetz, Pekrun, Hall and Haag, (2006) reported similar findings in the domain of Latin. In the Goetz et al. study, self-concept in Latin and intrinsic and extrinsic values in the subject were positively related to enjoyment and pride but were negatively related to anxiety, anger, and boredom. Although these studies demonstrate the cross-sectional associations between expectancy-value beliefs and emotions, they do not show the causal connections between the variables.
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The ‘Effect’ of Emotions on Expectancy-Value Beliefs

As noted above, some appraisal theories of emotions (e.g., Lewis, 2005) as well as models of emotions in education (e.g., Pekrun, 2006) argue that appraisals and emotions are linked reciprocally. Previous research that treated emotions as consequences of appraisals, as we have seen in the preceding section, showed that appraisals indeed are associated with emotions in academic contexts. Nevertheless, the causal effects of emotions on appraisals have rarely been the focus of empirical work. Yet support for the presumed effect of emotions on expectancy and value related appraisals can be gleaned from the literature on the influences of emotions on the content of cognition (see Forgas, 2001). This line of research has shown that emotions influence evaluative judgments. In particular, emotions have been shown to influence attribution for success or failure (Forgas, Bower & Moylan, 1990). Affective states have been shown to influence self-related cognitions such as self-evaluation, expectancies of self-relevant outcome and value (Forgas, 2000). Sedikides (1992) reviewed the effects of experimentally induced happy and sad mood states on self-related cognitions (e.g., goals, expectancies, values) and concluded that people in a happy mood, relative to those in a sad mood, made more favorable self-evaluative judgments, showed increased recall of positive self-relevant information and reported higher positive expectancy for self-relevant outcomes. An important implication of this finding is that affect has important consequences for self-conception. Nevertheless, only very few studies have directly examined how affective experiences influence expectancy–value beliefs in the context of motivation. In one of such studies Erez and Isen (2002), based on theoretical assumptions derived from expectancy-value model of motivation in workplace (Vroom, 1964), examined whether positive affect induction influenced participants’ expectation of performance on a moderately difficult task. They found that participants in happy mood expected to perform better than those in the neutral mood. Drawing on self-determination theory (Deci & Ryan, 1985), Isen and Reeve (2005) tested the assumption that positive affective experience is associated with choice behavior and increased intrinsic motivation, a construct akin to intrinsic value. In a sample of college students, induced positive affect was found to be associated with increased intrinsic behavioral display and increased enjoyment. Other studies have shown the effect of affective experiences on subjects’ attributions for achievement (Forgas, et al., 1990) and on subjects’ confidence in
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attaining the grades they were seeking (Carver & Scheier, 1994). Overall, the results suggest that affective reactions provide information about value, personal efficacy and importance of situations (Clore & Storbeck, 2006). A general conclusion from the studies on the effects of moods on expectancy related variables is that whereas sad moods are associated with pessimism, happy moods are associated with optimism. The findings tend to corroborate the mood-congruency hypothesis in that people in positive emotional states tend to give positive self-evaluative judgments whereas those in negative emotional states generally give lower self-evaluative judgments (see Clore, Schwarz & Conway, 1994). According to Higgins (2006), one prominent source of value is hedonic experience (pleasure or pain). People come to value a task based on history of the affective experiences with the task. In context of education, Expectancy-value model of motivation also posits that affective reactions in the academic context are apt to influence task value perceptions (Eccles & Wigfield, 2000). Thus both empirical and theoretical literatures tend to show that emotions could influence expectancy and value related appraisals.

Yet, with regard to the existing empirical evidence three important issues are of concern. One important concern is that in spite of their usefulness for empirical pursuit, the laboratory experiments in social psychology cannot be applied directly to the practices within educational settings. As is true of most experimental research, these findings are difficult to generalize beyond laboratory settings- implying their ecological limitations. Another important concern is that most of the research on the influence of affect on content of cognition focused on happy versus sad moods, which could be easily manipulated in laboratory contexts. Effects of discrete emotions such as anxiety, boredom and pride have rarely been the focus of most research. A final concern is that laboratory studies focus on the here-and-now and therefore cannot tell us whether the effects are consistent overtime.

The Present Study

Regardless of the mounting evidence on the cross-sectional associations between expectancy-value appraisals and academic emotions, the nature of the relations – specifically, the temporal order – remains unclear. Based on control-value theory of achievement emotions (Pekrun, 2006) and existing empirical evidence (e.g., Frenzel et al., 2007; Goetz et al., 2006
Meece, Wigfield & Eccles, 1990), we expected competence beliefs to be associated positively with enjoyment and pride and negatively with anxiety and boredom. Similarly, we expected intrinsic and attainment values to be associated positively with enjoyment and pride and negatively with anxiety and boredom. We expected utility value to be associated positively with anxiety, enjoyment, and pride but negatively with boredom (e.g., Frenzel et al., 2007; Meece et al., 1990; Pekrun, 2000; Zeidner, 1998). The conceptual model underlying the present investigation is presented in Figure 1. This figure includes four types of lines that represent four types of effects. Thick dotted lines represent control effects, thin dotted curved lines represent synchronous disturbance correlations, solid/thin lines represent stability effects, and solid/thick lines represent cross-lagged effects. Consistent with the reciprocal-relations model of control-value theory, we expected that expectancy-value beliefs and levels of emotions would predict each other over time. More specifically, we examined the following research questions:

1. Do prior competence beliefs predict subsequent anxiety and boredom negatively and subsequent pride and enjoyment positively, and vice versa?
2. Does prior intrinsic value predict subsequent anxiety and boredom negatively and subsequent pride and enjoyment positively, and vice versa?
3. Does prior attainment value predict subsequent anxiety and boredom negatively and subsequent pride and enjoyment positively, and vice versa?
4. Does prior utility value predict subsequent boredom negatively and subsequent anxiety, pride and enjoyment positively, and vice versa?

Figure 5.1 Conceptual model of the structural equation modeling analyses used to examine the reciprocal-relations. EV=Expectancy–value beliefs, EMO=Emotions, Prior=prior achievement.
METHOD

Participants and Procedure

The participants were 497 seventh grade students in two secondary schools located in two suburban communities in the Netherlands. Fifty-one percent of the participants were girls. Informed written consent was obtained from parents or guardians; no parent or guardian declined. Participants were informed of their freedom to discontinue participation at any time and of the confidentiality of the study. The participants provided data at three occasions: at the beginning (T1), in the middle (T2) and at the end (T3) of the 2007/2008 school year.

Measures

Expectancy-value measures

Measures of the expectancy-value beliefs included the students’ competence beliefs and their subjective value beliefs in math. The measures were adapted from Wigfield and Eccles (2000). Both measures were rated on a 5-point Likert type scale, ranging from 1 to 5.

Competence beliefs. The competence beliefs measure (4 items) assessed among others how good the participants thought they were at math was, how well they expected to do in the future in math, and how good they thought they would be at learning something new in math. An example item is “How good at math are you?” (1= not at all good, 5= very good). The Cronbach’s alpha reliabilities across the three waves were .84/.88/.88.

Value beliefs. The value beliefs measure (6 items) asked the participants how interesting math was, how important they thought being good at math, and how useful they thought math was. Wigfield and Eccles (2000) propose three components of value comprising intrinsic value (interestingness of a task), attainment value (importance of doing well in a task for confirming ones self-schema) and utility value (usefulness of a task for an individual’s future goals). A component factor analysis supported a three-factor solution explaining about 75% of the variance. The factors were intrinsic value (2 items) (e.g., How much do you like doing math?”(1= not at all, 5= very much), attainment value (2 items) (e.g., “How important is being good in math for you? (1 = not at all important, 5 = very important)) and utility value (2
items) (e.g., “How useful is learning math for you? (1 = not at all useful, 5 = very useful)). The Cronbach’s alpha reliabilities across the three waves were 0.83/.87/.84, .69/.74/.71 and 0.71/.76/.75 for intrinsic value, attainment value and utility value respectively in the present sample.

**Academic emotions measure.** Four academic emotions (anxiety, boredom, enjoyment and pride) experienced in mathematics were assessed using an adapted version of *Academic Emotions Questionnaire—Mathematics* (Pekrun et al., 2005). Students responded to 30 items assessing their level of anxiety, boredom, enjoyment and pride while learning math, studying math and while being seated in a math test. The scales were enjoyment of math (7 items; e.g., “I enjoy studying math”), pride (9 items; e.g., “I’m proud of my performance in math”), anxiety (8 items; e.g., “I get tense when studying math”), and boredom (6 items; e.g., “I get bored of studying math”). Participants responded on a 1 (not at all) to 5 (very much) scale, and the scores were averaged to form the emotion indexes (enjoyment: $\alpha = .83, .86, .85$; pride: $\alpha = .87, .85, .86$; boredom: $\alpha = .84, .88, .87$; and anxiety: $\alpha = .80, .84, .84$).

**Prior achievement.** Students’ scores on a national test at the elementary school (grade 6 USA) were taken as indicator of students’ prior performance. Their scores on this test ranged from 513 to 550 (M=538, SD =6.6). The possible range is between 501 and 550.

**Analytic Strategy**

To examine the reciprocal relationships between expectancy-value variables and emotions, we used structural equation modeling. The proposed model was tested using LISREL 8.80 for Windows (Jöreskog & Sörbom, 2006) using maximum likelihood estimation. To assess model fit we used a rigorous research based recommendation of Hu and Bentler (1999). Hence, a combination of the standardized root mean square residual (SRMR, .08 or less) and the comparative fit index (CFI, .95 or greater) and goodness of fit index (GFI, .90 or greater) were used to assess the fit of all the models tested. To determine statistical significance of the parameters the ratios of the absolute values of the parameters to their standard errors were inspected. In testing the models, the procedures we followed are all the same and are based on recommendations of Finkle (1995), and Anderson and Williams (1992). It should also be noted that this is an a priori model and no model modification attempt
has been made and therefore the degrees of freedom for all models is the same (12). We tested each of the models by allowing autoregressive effects between adjacent times. We also allowed the disturbances between concurrent measures to correlate (see Anderson & Williams, 1992). Because prior research on anxiety and motivational beliefs (competence beliefs, values and goal orientations) suggests that these beliefs come about as a result of previous performance or mastery experience, we controlled for the students’ prior performance such that it would predict the Time1 measurements. Given our participants’ early adolescence stage and their being on a critical transition year, controlling for such previous performance would provide important information about their adaptability to their secondary school environment.

RESULTS

To examine the reciprocal effects of expectancy-value beliefs and emotions, we used cross-lagged regression analyses based on a structural equation modelling framework (see Finkel, 2009). In total 15 models were tested. For reasons of clarity, we present the results using the beliefs as labels for the models. In general, all the models tested fitted the data reasonably well suggesting that the proposed cross-lagged models replicate the data. The results are presented in Figures 5.2-5.9. As mentioned above, four types effects were estimated. For the sake of clarity, the effects of prior achievement on Time 1 endogenous variables and the correlations between concurrent disturbances are not depicted in the structural diagrams. Prior achievement predicted Time 1 competence beliefs, Time 1 utility value and Time 1 pride significantly. Forty-two out of 48 possible disturbance correlations were significant with values in the range of $|\beta| \leq .08$. The stability coefficients, reflecting the autoregressions of each variable were all significant and varied slightly around .46.

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8 Among six possible correlations between attainment value and anxiety across the measurement moments, only one was significant. Hence, no further analysis was conducted.
Table 5.1 Means and Standard Deviations for Expectancy-value Beliefs and Emotions for the Three Measurement Occasions

<table>
<thead>
<tr>
<th></th>
<th>Time 1</th>
<th>Time 2</th>
<th>Time 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M (SD)</td>
<td>M (SD)</td>
<td>M (SD)</td>
</tr>
<tr>
<td>Competence beliefs</td>
<td>3.43 (.60)</td>
<td>3.32 (.70)</td>
<td>3.16 (.77)</td>
</tr>
<tr>
<td>Intrinsic value</td>
<td>3.24 (.78)</td>
<td>2.93 (.84)</td>
<td>2.70 (.85)</td>
</tr>
<tr>
<td>Attainment value</td>
<td>3.91 (.72)</td>
<td>3.70 (.77)</td>
<td>3.52 (.84)</td>
</tr>
<tr>
<td>Utility value</td>
<td>3.54 (.66)</td>
<td>3.44 (.72)</td>
<td>3.24 (.79)</td>
</tr>
<tr>
<td>Anxiety</td>
<td>2.00 (.55)</td>
<td>2.03 (.57)</td>
<td>2.06 (.64)</td>
</tr>
<tr>
<td>Boredom</td>
<td>2.19 (.78)</td>
<td>2.46 (.92)</td>
<td>2.64 (.96)</td>
</tr>
<tr>
<td>Enjoyment</td>
<td>2.36 (.76)</td>
<td>2.12 (.72)</td>
<td>1.98 (.74)</td>
</tr>
<tr>
<td>Pride</td>
<td>2.92 (.74)</td>
<td>2.74 (.80)</td>
<td>2.63 (.79)</td>
</tr>
</tbody>
</table>

**Competence Beliefs and Emotions Models**

The four competence beliefs and the emotions models fitted the data reasonably well \( \text{SRMR = (.03 - .05); CFI = (.94 - .99); GFI = (.95 - .97)} \). Nevertheless, not all cross-lagged path coefficients were significant. The standardized path coefficients are presented in Figures 5.2 and 5.3. In the anxiety model, the results showed that competence beliefs predicted subsequent anxiety, and prior anxiety predicted subsequent competence beliefs. This clear pattern however was not evident in the other models. In fact, in the pride model none of the cross-lagged coefficients was significant. Whereas boredom and enjoyment had significant effects on subsequent competence beliefs, the reciprocal effect of competence beliefs on the emotions were not significant. Hence, a clear pattern of reciprocal associations between competence beliefs and emotions is observed only in anxiety model.
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Figure 5.2. Competence and anxiety / boredom; all $\beta$s $\geq .05$ are significant at least at $P < .05$.

Figure 5.3. Competence and enjoyment / pride; all $\beta$s $\geq .05$ are significant at least at $P < .05$. 
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**Intrinsic Value and Emotions Models**

The four intrinsic value models also fitted the data reasonably well [SRMR = (.02 - .05); CFI= (.96 - .99); GFI = (.96 -.99)]. Figures 5.4 and 5.5 present the standardized path coefficients. Inspection of the cross-lagged path coefficients revealed that intrinsic value had a significant longitudinal effect on anxiety such that higher levels of intrinsic value were associated with lower level of subsequent anxiety. However, the reciprocal effect of anxiety on intrinsic value was not significant. Yet enjoyment and pride had statistically significant lagged effects on subsequent intrinsic value. Higher levels of enjoyment and pride were associated with higher levels of intrinsic value. Students who reported higher levels of enjoyment and pride in the previous trimester also reported higher levels of intrinsic value in the subsequent trimester. Finally, intrinsic value and boredom showed a clear reciprocal association. Students who reported higher levels of intrinsic value the previous trimester reported lower levels of boredom the subsequent trimester and *vice versa.*
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Figure 5.4. Intrinsic value and anxiety / boredom; all $\beta$s $\geq .05$ are significant at least at $P < .05$

Figure 5.5. Intrinsic value and enjoyment / pride; all $\beta$s $\geq .05$ are significant at least at $P < .05$
Attainment Value and Emotions Models

The three models that tested the cross-lagged associations between attainment value and the three emotions fitted the data very well [SRMR = (.03 - .07); CFI= (.95 - .98); GFI = (.95 -.98)]. The standardized path coefficients are presented in Figures 5.6 and 5.7. The pattern of relations is similar to the ones found in the intrinsic value models. Previous attainment value had a statistically significant effect on subsequent pride and previous pride had a significant effect on subsequent attainment value. The other patterns were not consistent. Whereas boredom and enjoyment had significant effects on subsequent attainment value, the effects of attainment value on the subsequent emotions were not evident.

![Diagram showing Attainment Value and emotions models](image)

Figure 5.6. Attainment value and boredom; all $\beta$s $\geq .05$ are significant at least at $P < .05$
Utility Value and Emotions Models

Finally, the four utility value models fitted the data very well \( [\text{SRMR} = (.04 - .06); \text{CFI} = (.95 - .98); \text{GFI} = (.95 - .98)] \). Figures 5.8 and 5.9 present the standardized path coefficients. Utility value had statistically significant effect on subsequent anxiety and vice versa. That is, prior utility value predicted subsequent anxiety and prior anxiety predicted later utility value. A similar effect was observed for utility value-pride associations. These two reciprocal effects however did not hold in the other models. While both boredom and enjoyment had a statistically significant effect on subsequent utility value, utility value did not have a significant effect on the emotions.
Figure 5.8. Utility value and anxiety / boredom; all $\beta$s $\geq .05$ are significant at least at $P < .05$

Figure 5.9. Utility value and enjoyment / pride; all $\beta$s $\geq .05$ are significant at least at $P < .05$. 
DISCUSSION

The main goal of the current study was to investigate the reciprocal relationships between expectancy-value beliefs and four academic emotions. On the basis of theory and previous research, we hypothesized that students’ expectancy-value beliefs (competence beliefs, intrinsic value, attainment value and utility value) would be reciprocally associated with their emotions (anxiety, boredom, enjoyment and pride). The three-wave cross-lagged longitudinal analyses revealed mixed findings. Although there were some significant reciprocal effects, several patterns were in either one or the other direction. In addition, a few did not show significant associations in either direction. In general, the analyses revealed distinct sets of findings.

One set of findings was that in support of the general assumption that appraisals and emotions are reciprocally related (Pekrun, 2006), five models exhibited consistent reciprocal effects. First, prior competence beliefs predicted subsequent levels of anxiety negatively and vice versa. Contemporary appraisal theories of emotion suggest that higher self-evaluative judgments like self-competence promote a sense of agency that biases appraisals of an encounter as benign, which in turn are associated with higher levels of positive and lower levels of negative emotions (Lazarus, 2001). On the other hand, theories of affect-cognition relations hypothesize that higher levels of negative emotions in context foster lower self-evaluative judgments. In line with these propositions, Bandura (1997) suggested that anxiety may result from lower self-efficacy appraisal, but higher levels of anxiety might also lead to lower self-efficacy judgments. The current finding is consistent with such assumptions and shows a dynamic association between competence judgments and anxiety. The significant effect of prior competence beliefs on subsequent anxiety found in the current study gives credence to the generalized assumption that higher efficacy judgments lead to lowered anxiety and corroborates several cross-sectional studies (e.g., Frenzel, et al., 2007; Goetz, et al., 2006; Smith & Ellsworth, 1985) and a longitudinal study (Meece et al., 1990) that tested such assumptions. On the other hand, the significant effect of prior anxiety on competence beliefs tend to support models of affect-cognition links (e.g., Bower, 1992) that argue that negative emotions such as anxiety might bias self-evaluative judgments such that highly anxious people would evaluate their self-competence as low.
Second, intrinsic value was reciprocally associated with boredom such that an increase in intrinsic value was associated with a decrease in boredom and vice versa. Intrinsic value is usually contrasted with boredom. Lack of interest in activity or task has been mentioned as a primary feature of boredom (Silvia, 2006). Similarly, Pekrun’s control-value theory of achievement emotion posits that boredom is experienced when an academic activity is perceived as having no subjective value. In fact, as mentioned earlier, this theory posits that appraisal of value and emotions, including boredom are reciprocally related. The current finding lends support to such reciprocal assumption. Recently, Schunk, Pintrich and Meece (2008) suggested that repeated emotional experiences in the past could lead to a positive or negative value judgment of a task. The current finding supports such assumption in that students’ prior boredom experiences in mathematics predicted their subsequent intrinsic value judgment of the subject.

Third, attainment value and pride showed a consistent reciprocal effect overtime. Attainment value refers to an individual’s perception of the importance of a task. It denotes the degree to which students evaluate the tasks as confirming or disconfirming their sense of themselves (Wigfield & Eccles, 2000). As noted by Eccles (2005), individuals seek activities that confirm their self-identity. According to a cognitive appraisal model of self-conscious emotions (Tracy & Robins, 2007), identity relevance (e.g., Is math related to who I want to become?) is an important appraisal for the emotion of pride to occur. Our findings show that students’ attainment value, which reflects evaluation of math as reflecting their identity, influenced the students’ pride experience, which also influenced their value judgment in turn. People with higher attainment value are the ones who do the activities they perceive as the reflection of their identity. Success in such identity related tasks or activities may therefore be associated with the experience of pride, which in turn could possibly influence subsequent value judgment.

Fourth, utility value and anxiety were reciprocally related such that an increase in one was also related to an increase in the other. Although this result appears surprising at first sight, a closer examination of the nature of the two constructs shows the plausibility of the finding. Utility value reflects students’ future plans. Students with higher utility value might tend to focus on performing in the subject to realize their goals. Such performance orientation
breads sense of uncertainty, which is a major feature of anxiety. Research on test anxiety has also shown the positive association between utility value and test-anxiety (see Zeidner, 1998). In appraisal theorists’ view, judgment of relevance is basic to emotional presence. For instance, Frijda suggests that appraisal of concern is the primary cause for an emotion to occur. He argues that concern is hierarchical in that there are immediate concerns and future goals (e.g., instrumental value). Both, according to Frijda, are of paramount significance for the instigation of emotions. We experience emotions about something we consider useful for our social group or ourselves.

Fifth, consistent with our hypothesis, utility value and pride were positively reciprocally related. As mentioned above, utility value implies instrumentality of mathematics for reaching future goals. Positive emotions such as pride and enjoyment are experienced when progress toward goals are promising (Oatley & Johnson-Laird, 1987). By implication, students’ reported pride may reflect their self-evaluation of their own performance in mathematics which may indicate where they are in terms of their future goals. Indeed, Pekrun (2006) suggested that intense pride is likely to be experienced under conditions in which success is achieved in a task that is judged as having higher instrumental value for the student. Overall, the five reciprocal effects found in the current study lend support to reciprocal causal assumptions of control-value theory of achievement emotions (Pekrun, 2006).

Another set of findings was that in nine of the models tested, prior emotions influenced subsequent appraisals but not vice versa. In particular, prior enjoyment and pride positively predicted subsequent value beliefs (intrinsic value, attainment value and utility value). In addition, enjoyment predicted subsequent competence beliefs. On the other hand, boredom negatively predicted subsequent competence beliefs, attainment value and utility value. Taken together, the results are generally consistent with a great deal of social psychological studies that have demonstrated the effect of positive and negative affect on a variety of cognitive processes including task and self-evaluative judgments (see Isen, 2004; Sedikikes, 1992, for reviews). For instance, several studies that examined the effect of emotions on self-evaluative judgments like self-efficacy expectations have found that negative moods led to lowered self-evaluative judgments whereas the opposite happened for positive mood. One such study
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manipulated sad and happy moods states among a sample of university students to evaluate the potency of an associative network model of affect-cognition relations. The study found that students in whom a happy mood was induced reported higher levels of self-efficacy in a wide variety of social skills than those in a neutral or sad mood condition (Kavanagh & Bower, 1985). In a related study, Forgas, et al. (1990) found that happy subjects made more internal and stable attributions for real life exam performance than sad subjects did. Although internal attribution is not equivalent with competence perception, there is ample evidence that attributions to internal, stable and controllable causes tend to boost one’s confidence in subsequent task engagement (Weiner, 1985). In a recent experiment on the effect of positive affect on intrinsic motivation, Isen and Reeve (2005) found that subjects in whom pleasant affect was induced displayed more intrinsically motivated behavior and increased report of enjoyment of the experimental task. Indeed, several cross-sectional studies have found associations between competence and value beliefs and emotions (e.g., Frenzel, et al., 2007; Goetz et al., 2006). Some appraisal theorists (e.g., Frijda & Zeelenberg, 2001) have argued that appraisal can be viewed as an outcome rather than as an antecedent. Although this seems radical, studies on the effects of emotions on self-evaluative judgments (as discussed thus far) suggest that this may be the case.

Another important finding worth discussing is the relationship between intrinsic value and anxiety. Whereas intrinsic value predicted subsequent anxiety, prior anxiety did not have a significant effect on subsequent intrinsic value. Previous cross-sectional studies have consistently found significant negative associations between intrinsic value and anxiety (e.g., Frenzel et al., 2007; Goetz et al., 2006). The current finding adds to the assumed temporal order in these studies. The finding also lends support to the assumption that appraisals precede emotions. Given the findings discussed in the preceding paragraph, we caution that such an assumption should not be taken for granted.

Finally, in the model that involved the longitudinal associations between competence beliefs and pride, none of the cross-lagged path coefficients were significant. Scholars have noted that attributions of success to internal factors give rise to pride (Weiner, 1985; Lewis, 2008). Given the argument that these types of causal ascriptions also enhance self-evaluation of competence and that pride experience enhances self-evaluative judgments of competence
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(Bandura, 1997), one would expect reciprocal associations between competence beliefs and pride. The current finding, however, suggests that once prior levels of the variables are controlled, the lag effects are not significant. One possible explanation is that students’ competence perceptions as well as their pride experience tend to depend on self-evaluation of academic performance, which becomes more realistic through time. Hence, competence beliefs and pride may take parallel growth paths instead of one causing the other.

This study has several strengths. First, the reciprocal model was evaluated using a prospective, longitudinal design involving three measurement occasions. The availability of three data collection points afforded the opportunity to test if the hypothesized reciprocal process was evident across more than one time period. Second, the present study examined the longitudinal associations between three components of value and four emotions commonly studied in academic settings. Interestingly, the use of the three components revealed their differential associations with emotions. Third, the present study evaluated the cross-lagged relations controlling for concurrent disturbance correlations and autoregressive effects. These conservative modelling approaches help to reduce the concern that associations among variables are simply an artefact of unmeasured third variables.

In spite of these methodological strengths, the present study also has several limitations. First, the design of the research was correlational. As such, definitive causal conclusions are impossible. Yet the fact that the analyses controlled for temporal ordering of variables is an improvement over cross-sectional research designs. Moreover, one should note that true experiments on students’ emotions in the classroom are ethically and practically difficult if not impossible. Second, the present study considered a relatively short time span. Although this period covers an important critical transition period worth of investigation, a longer time span might help to paint a clearer picture of appraisals and emotions over time. On the contrary, given the transient and stable nature of both appraisals and emotions, one may argue that reciprocal relations between daily appraisals and daily emotions may also be more informative. Only future research, probably through experience sampling methodology could test such reciprocal effects. Third, the study used only self-reports for both appraisals and emotions. Future research should use additional measurements such as nonverbal expressions.
and physiological reactivity presumably on a limited number of students for a shorter time interval. The use of such multiple methods helps to rule out common method variance. In the current study, however, the cross-lagged effects are unlikely to account for such bias because the tests controlled for autoregressive (stability) effects as well as correlated disturbances. Finally, future research is needed to test the reciprocal relationships on students younger and older than those in the current sample.

These limitations notwithstanding, the findings of the current study have important implications for theory and practice. The reciprocal effects found in the current study point to the possibility that enhancing students’ competence and value beliefs is beneficial for cultivating adaptive emotions and vice versa. Although much remains to be investigated, the current findings on the primacy of some emotions on some appraisals also suggest that for those kinds of appraisals, enhancing students’ emotions through instructional practices may improve students’ competence and value beliefs. The findings also inform emerging theoretical models of emotions in education by highlighting the fact that the reciprocal effects may only hold for some appraisal-emotion linkage and that focusing on the whole rather than the parts of the linkages may blur the true picture of the relations between appraisals and emotions.

In conclusion, this study demonstrates the utility of integrating affect-cognition approaches with appraisal theories of emotions in education to better understand the reciprocal dynamics between appraisals and emotions in school settings. The study shows that although the hypothesis that appraisals and emotions are reciprocally associated has some grain of truth, the dominant view that appraisals are causes of emotions needs careful scrutiny.