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Research Article

The Joint Effects on Mathematics achievement: A Multi level Analysis of Person – Context Interactions

Chung Chin, Wu

Institute of Education, National Cheng Kung University, Taiwan

Author E-Mail: minin-72704@yahoo.com.tw

Abstract

Academic goals directed personal attribution and the interpretations of internally and externally negative emotions, which was thought to have great impacts on learning. Personal and contextual factors may interplay with each other, and result in joint effects on mathematics achievement. The cross-level interactions of personal level variables (gender, academic goals, attribution, and emotional state-orientation personality for students) and context level variables (emotional state-orientation personality for teachers and the negative emotional transmission) on mathematics achievement were investigated in present study. Three hypotheses of cross-level interactions erected around three academic goals were tested: the inversing hypothesis, the minimizing hypothesis, and the reinforcing hypothesis. The large database composed of 14,461 high school students nested within 946 classes was adopted to provide substantial empirical evidences. Owing to hierarchical structures of the data, potential similarity within classes in math achievement, and the likely presence of cross-level interactions, the multilevel analysis were introduced. The results indicated that there were considerably variances within classes in math achievement, and most of residual variance (71.92%) could be explained by individual and contextual level variables. The cross-level interactions of inversing hypothesis was supported, it suggested that students who possessed learning goal could

inverse the negative effect of negative emotional information and resulted in better mathematics achievement. The minimizing hypothesis and reinforcing hypothesis for students who possessed social goal were partly supported, because gender effect was not significant. It meant that the negative effects of intrinsically and extrinsically negative emotional information may be minimized when they proceed efforts attribution. If, however, they proceeded ability attribution, the negative effect of negative emotional information would be reinforced. Likewise, the reinforcing hypothesis for students who explicitly lacked goal and proceeded ability attribution was also evidenced identical reinforcing negative effect. Implications for practice and future researches were also discussed.

Keywords: Academic Goals, Attribution, emotional state-orientation personality, negative emotional transmission, multilevel analysis

INTRODUCTION

The interplay among physiology, psychology, and context may have joint effects on learning performance. In daily school life, students interacted with teachers and classmates, and received constant cognitive and affective information from the context. Students responded to contextual information variedly from person to person with respect to their physiological and psychological characters. Individuals subjectively interpreted contextual information and selectively transformed it into intrapersonal belief via assimilation and accommodation, in turn directed achievement-related behavior and performance (Schunk et al., 2008).

The motivational and emotional mechanism may influence achievement performance. The academic goal and attribution were the representation of motivational belief, which directed the interpretation of internally/externally and positively/negatively affective information, achievement-related behavior and learning performance. The academic goal may either protect individuals from the impairments of negative emotions, failure experience or reinforce the effects. Although, the effects of psychological viewpoint on achievement performance were predominant in current researches, the gender may be also interplay with varied psychological trait and contextual characters. Hence, the joint effects of physiology, psychology, and context should be considered simultaneously when it comes to the influences on learning performance.

Gender differences in mathematics achievement

The mathematics performance was one of the most concerned issues in schooling to date. The effect of gender difference on mathematics achievement was an ongoing debate in past several decades. After analyzing the cross-national dataset of TIMSS (2003) and PISA (2003), Else-Quest, Hyde, and Linn (2010) indicated that overall gender similarity existed in mathematicsematics performance, but they argued that there was considerable variability among nations. Moreover, boys reported more positive math attitudes and affect toward mathematics. It implied that more

nationwide researches were needed to further investigate the effects of gender differences on mathematics achievement.

Gender was generally considered as the representation of physiological character, but it should not thought to be the only factor which have influences on mathematics achievement. Nosek and Smyth (2011) examined gender differences in learning attitudes toward mathematics, and indicated that women showed stronger negativity and performed worse in mathematics than men did. It suggested that the differences in mathematics achievement may depend on the interaction between gender and other psychological characters. Therefore, it was beneficial for taking other psychological traits into consideration to gain deeper insight in investigating the differences of mathematics achievement.

Academic goals and attribution in mathematics achievement

The motivational belief had remarkable impacts on mathematics achievement (Ercikan et al., 2005). Aylaz et al. (2012) even reported motivational beliefs toward mathematics accounted for nearly one-third of the variance in mathematics test scores. Hence, learners may differ from learning achievement, resulted from the interaction of varied motivational beliefs (Shen et al., 2007).

The goal theory was a predominant field in the body of motivational literature (Schunk et al., 2008). It argued that learners performed similarly in mathematics may not necessarily warrant that they engaged in learning for the same reasons. For instance, regarding two students who strived to get an “A” in mathematics, one may devoted in mastering the learning task (Elliot et al., 2005; Harackiewicz et al., 2002; Pinrich, 2000), but the other may expect the praise from parents or teachers (Ryan and Shim, 2006; Urdan and Maehr, 1995). It shed light on the reasons behind the goals may orientate motivational propensities and then profoundly influenced mathematics achievement.

Academic goals were regarded as different reasons behind the specific aims, three academic goals may lead students toward different learning status:

(a) Learning goals, in which students interested in learning in order to develop their competence or master the task (Dweek, 1986; Elliot and McGregor, 2001b; Nicholls, 1984).

(b) Social goals, in which students expected to obtain respects from others or meet others expectation, when they involved in learning processes (Wentzel, 1998, 1999).

(c) Explicit lack of goals, in which students may hold implicit reasons, but they were not consciously aware of. Hence, the unconscious reasons cannot efficiently elicit and direct their learning behavior and performance. As a result, their behavioral intention was seemed more likely to be trigger by external accident and cause unpredictable outcomes.

There were substantial researches demonstrated that learning goals benefited for academic achievement (Dupeyrat and Marine, 2005; Gutman, 2006; Keys et al., 2012; Lin et al., 2009; Schraw et al., 1995; Sins et al., 2008; Tanaka and Yamauchi, 2001; Wolters, 2004). Wentzel (1991, 1993) had demonstrated that both social and learning goals related to adolescents’ academic performance, But, relative to learning goals, a few studies were conducted and positive effects of social goals on learning achievement were pointed out (e.g. Mouratidis and Michou, 2011; Nakaya, 1998; Urdan and Maehr, 1995). Hence, researchers suggested that further investigations were undoubtedly needed (Shen et al., 2007). The effects of explicit lack of goals were also under investigation.

Central to a learning goal was the belief that efforts and outcomes covary, and it was the attributional belief pattern that maintains achievement-directed behavior over time (Weiner, 1979, 1985). The focus of attention is on the intrinsic value of learning (Nicholls, 1984), as well as effort utilization. One's sense of efficacy is based on the belief that effort will lead to success or a sense of mastery. The goal belief and attributional belief ought to interplay with each other.

Although, academic goals were contributed to answer why students engaged in learning processes, but it was insufficient for realizing how academic goals interacted with experiences of success and failure. According to attribution theory, students may ascribe success or failure to effort, extrinsic matters, and ability (Weiner, 1985). Students who possessed learning goals stressed on develop self-competence and mastered learning task. As a result, they may tend to attribute success to internal factors and failure to extrinsic factors (Aylaz et al., 2012). It may be beneficial for protecting them from the impairment of learning intention.

Weiner (1985) argued that attributed failure to internal causes was linked to negative emotion, and attributed to ability caused much detrimental effects than effort did. For students who possessed social goals, Aylaz et al. (2012) demonstrated that they may attribute both success and failure to efforts so as to endeavor to meet others expectation or demand, but gender differences was not taken into account. There were supposed to be a difference between boys and girl under different culture. For girls, they may ascribe both success and failure to efforts because that is a virtue in traditional Eastern culture. But, boys were given high expectation of ability, promoted them more likely attribute both success and failure to ability. Boys may be devoted much efforts to obtain positive evaluation or avoid negative evaluation to their ability from others. If the negative evaluation was externally uncontrollable, their ability attribution may cause detrimental effects on their learning performance. In this regard, social goals may be more beneficial for girls who possessed efforts attribution than boys who tended to proceed ability attribution.

For individuals, who belonged to explicit lack of goals, their psychological responses apt to evoke by external events. Therefore, they may ascribe their success and failure to ability, efforts, and external events, in turn, their performance varied in the uncertain fashion. Specifically, they may tend to attribute success and failure to external events, and easily to hold emotional SOP, which were resulted in being affected by negative emotion. It may be reasonable that the result of interaction between academic goals and attribution may have joint effects on mathematics achievement.

Personal negative emotion and emotional personality

Achievement-related activities and social interactions were two important ingredients in schooling. Achievement-related emotions accompanied by outcomes of achievement-related activities (success or failure) have already been depicted by Weiner (1985). The effects of anxiety on learning performance received extensive concerns (Pekrun, 2000), depression also attracted numerous attentions (e.g. Andrews and Wilding, 2004; Grimm, 2007). Inversely, more neutral negative emotions such as loneliness were rarely investigated so far (e.g. Steven et al., 1984).

Anxiety likely engendered from learning processes, especially when persons expected to encounter negative evaluations or received negative feedbacks. Negative emotions resulted from teachers or classmates represented negative evaluation, which may cause individual anxiety and influence achievement (El-Anzi, 2005; Stankov, 2010).

Depression generated from retrospection and may accompany by anxiety, and both anxiety and depression had been indicated an inverse relationship to achievement performance (Walkiewicz et al., 2012).

Loneliness suggested far psychological distance from others, and it may be accompanied by depression or anxiety. It had not only been reported an strong positive correlation between depression and loneliness ($r = 0.608$, $p < 0.001$) (Aylaz et al., 2012), but had an association between loneliness and poor achievement (Rotenberg and Morrison, 1993; Steven et al., 1984). Klicpera and Klicpera (2003) even point out that there were approximately 15% adolescents felt lonely.

It seemed possible that the effects of these three kinds of negative emotion may be intertwined within persons. Students may suffer from diverse negative emotions simultaneously when they engaged in learning activity. It implied a negative emotion cycle, and students or teachers who easily fell into this cycle were regarded as state-orientation personality (SOP) (Kuhl, 1985; Kuhl and Kazen, 1994). State-orientation personality had been demonstrating a relationship to negative emotions (Blunt and Pychyl, 1998) and was weak in self-regulation of negative emotion (Koole and Fockenberg, 2011). It meant that they were more likely to be affected by self-generated and others negative emotions. If this was the case, negative emotions may emerge joint effects on achievement. So far, it was little known of the effects of emotional SOP on learning performance, and the interactions among emotional SOP, motivational beliefs, and gender were also unclear.

Negative emotional transmission

In addition to emotional SOP may reinforce the influences the negative effects of negative emotions. The emotional transmission within classroom may be also possible. The formation of classroom emotional atmosphere was through the emotional transmission between teachers and students. Papsova et al. (2012) argued that students' school satisfaction correlated with classroom atmosphere. The positive linkage between teacher enjoyment and student enjoyment was contributed to the formation of positive classroom atmosphere (Frenzel et al., 2009), and it was beneficial for promoting academic achievement (Meelissen and Luyten, 2011). Instead, the effect of negative classroom atmosphere on mathematics achievement was under investigated, although, it could be supposed to the detrimental effects on learning performance.

Individuals emotional SOP may reinforce the effects of negative emotion. As a result, two negative emotion sources (teacher and students) may be concurrently contributed to the increases of classroom negative emotion transmission (CNET), and the CNET may interact with emotional SOP in turn. It implied that the formation of negative emotion was a process of reciprocal influences between individuals and context.

In summary, the effects of contextual negative emotions (teacher negative emotion and CNEA) may cause inconsistent effects from person to person. Specifically, the effects of two individuals negative emotion sources (teachers and students) may interplay with their emotional SOP, physiological (e.g. gender) and psychological traits (academic goals and attribution), and formed the CNET. Consequently, CNET may be returned affect them, and resulted in extremely diverse achievement performance. The outcomes would be more complicated when gender, motivational beliefs, the emotional SOP, and contextual negative emotions were considered.

The effects on learning performance were not straightforward attributed to one factor. Instead, the complicated interactions came across physiological, psychological, and contextual characters, which were held remarkable impacts. The joint effects of intrapersonal psychology (academic goals, attribution, and emotional SOP for students) and context (emotional SOP for teachers and CNET) may be more important relative to individual physiology. But, the input of external emotion information may be also possible to interact with individual gender, motivational belief and emotional SOP, and further direct the differences of achievement-related outcomes. If this was the case, the influences of gender may be minimized when intrapersonal psychology and context were taken into consideration.

Overall inferences and hypotheses

A growing body of literature suggests that academic achievement may be affected through motivational and emotion mechanisms (e.g. Ahmed et al., 2010; Dubow et al., 1991; Wentzel, 1994). It suggested that the investigation of learning performance from single aspect such as motivational beliefs was insufficient, because the motivational beliefs may interact with emotional personality and information, and resulted in varied results on learning performance.

Academic goals direct attributional type had been demonstrated by researches that were mentioned earlier. Students possessed learning goal were unlikely to be influenced by negative emotion such as anxiety and depression (Elliot and McGregor, 2001a; Pekrun et al., 2006). Likewise, Mouratidis and Michou (2011) also indicated that social goals was positively associated with positive emotions and negatively associated with negative emotions (Mouratidis and Sideridis, 2009). It may represent that students who possessed learning goal and social goal were supposed to respond to external negative emotion in the same manner.

Abnormalities of attributional style have been implicated depression (Blackwood et al., 2003), and anxiety may also produce from the anticipation of failure or negative evaluation. Negative emotion was served as negative evaluation, it suggested that attributional type may interplay with emotional SOP and contextual emotion information, but how the joint effects worked ought to depend on the level of academic goals.

Because large motivational literature asserted that academic goals may act the crucial role when students proceeded the interpretations of psychological responses and external negative emotions. Present study herein concluded all contentions mentioned above, and further made three inferences on mathematics achievement, which were erected around academic goals. As a result, three hypotheses of cross-level interactions: inversing hypothesis, minimizing hypothesis, and reinforcing hypothesis, were test and delineated as following:

Inversing hypothesis

It referred to students who possessed learning goals were supposed to engender positive emotion and inhibit the generation of negative emotion (Elliot and Dweck, 1988; Pekrun et al., 2009). Hence, no matter what gender they were, they tended to proceed self-serving attribution (e.g. ascribe failure to external events), and stressed on mastering learning task. Eventually, the emotional SOP were less likely produced and took effects, and the negative effects of

negative emotion on mathematics achievement may be offset and reversed, resulted in outperforming others.

Minimizing hypothesis

For girls who possessed social goals, which were supposed to attribute both success and failure to efforts, in order to meet others expectation or demand. As a result, if emotional SOP for teachers and students, and CNET were all at mean level, the detrimental effects of negative emotions may be minimized so as to sustaining their social relatedness, and may result in similar mathematics achievement with those who possessed learning goals.

Reinforcing hypothesis

It suggested that for students who belonged to lack of goals, no matter what gender they were, their emotional SOP was most likely to increase the effects of others negative emotion, and negative influence on learning performance may be enlarged, if they ascribe success/failure to ability. Likewise, boys who possessed social goals may more likely to demonstrate themselves and attribute their success and failure to ability. The external negative emotion was regarded as negative evaluation, social goal may direct them to strive to avoid negative evaluation. But, they may be more easily influenced by uncontrollable and external negative emotion, their negative emotion may be increased and interacted with their emotional SOP and CNET. Finally, social goal may be helpless to protect their behavioral intention from the effect of external negative emotion, the negative effects on their mathematics achievement may be reinforced.

Methodological consideration

Students were nested within classes to which they belonged, they might be influenced by their teachers and classmates (Singer, 1998), then teachers and classmates might be influenced by individuals in turn. Moreover, students instructed by the same mathematics teacher may also appear certain similarity in learning performance.

Students in present study were sampled from hierarchical population (e.g. students nested within classes), this sample method were known as multistage sampling or stratified sampling, and multilevel analysis was design to deal with this kind of dataset (Goldstein et al., 2002). In this regard, specifically, it was designed to handle two main problems. First, it was related to heavily leaned assumption of independence of the observation in classical statistical tests of regression. The multilevel analysis noticed that samples were selected as clusters via multistage sampling method, to certain extents, it may occur notable dependences which should be considered.

Second, it distinguished the stratification from same level variables. In myriads of literatures, context-level variables (e.g. teachers-related variables) were treated as personal-level variables, and were directly regressed to dependent variable such as achievement. Hox (2010) argued that treated higher level variables as lower level variables was inadequate, if it was the case, some statistical (e.g. spuriously significant results) and conceptual problems (e.g. ecological fallacy) might be engendered.

Moreover, the classical analysis method was strongly stood on the assumption: the sum of expected residual equaled to zero, and variables were viewed as fixed effect. In fact, each variable induced one error term, and these errors were not taken into consideration in conventional regression model. Furthermore, variation also viewed as constant rather than random fluctuation. As a result, multilevel analysis was adopted to take all residual variances into account, and allowed fixed and random effects to be incorporated simultaneously into mixed model.

There were two distinct variable levels - personal and contextual levels in present study. Personal-level variables comprised gender, academic goals, attribution, and emotional SOP for students. Context-level variables were consisted of CNET and emotional SOP for teachers. Present study herein regarded personal and contextual variables as respective level variables to investigate the cross-level interaction.

The multicollinearity was usually the problem in many studies which conducted multiple regression analysis, especially when there were many variables in the model (Dielman, 2005). Because there were multiple explanatory variables in present study, the multicollinearity may be serious problems in data analysis. To avert this problem, emotional SOP for teachers and students and CNET were all centered to grand mean (Singer, 1998).

In educational psychology, more and more researches noticed these drawbacks mentioned above, and investigated the effects of cross-level interaction on achievement-relevant outcomes (e.g. Lau and Nie, 2008; Murayama and Elliot, 2009). However, since achievement-related negative emotion were found to play a vital role in learning and received increasing attentions. Investigating the interactions of individual and contextual negative emotion on achievement should be separated as distinct level, and simultaneously stressed on the joint effects of motivational beliefs and emotional personality for better interpreting students' achievement performance.

METHODS

1. Participants

Participants in present study were adopted from large database- Taiwan Education Panel Survey (TEPS). It conducted four waves longitudinal study each two years, and started collection of junior high students' data in 2001 and traced them until 2007. Data derived from year 2003, and junior high school students had enrolled in high schools. Participants were multistage random sample from the population, they were chosen at cluster level (classes). Consequently, 338 high schools with a total of 1,244 classes and 19,088 senior high school students (9,835 males and 9,253 females) were selected. In light of the suggestions proposed by Hox (2010), cross-level interaction should be tested under 50/20 rule, it meant that there should be 20 students nested within each of 50 classes. After the incomplete answers, unreasonable data, and the classes contained less than 20 students were deleted, multilevel analysis was conducted on the basis of 946 classes with a total of 14,461 observations (7,459 males and 7,002 females).

2. Measures and variables

There were six variables in present study, including four personal level / level 1 variables (gender, academic goals, attribution, and students' emotional SOP) and two contextual level / level 2 variables (teachers' emotional SOP and classroom negative emotion transmission). Items with respect to gender, academic goals, and attribution were nominal variable with two options – "yes" or "no", while another three emotion-related variables were latent variable.

Coding

All predictors were used effect coding (Hox, 2010). In terms of gender, male and female were given 0.5 and -0.5 respectively. There were three kinds of academic goals: learning goal, social goal, and lack of goal, and the reference group was coded -1. Hence, there was a vector for academic goals: [1, -1, 0] which were represented learning goal, social goal, and lack of goal in order. Likewise, three types of attribution: efforts attribution, external attribution, and ability attribution, and the reference group was coded -1. Hence, one vector for attribution was created: [1, 0, -1] which was in line with the order. The coding plan was drawn according to the potential effects suggested by researches and postulated interaction by present study.

Students' state-orientation personality

Individual negative emotion included anxiety, depression, and loneliness. Students easily fell into this negative emotion cycle indicated that they may persist emotional state-orientation personality. The students' state-orientation personality was aggregated from these three negative emotions. After aggregating, the context effect was checked, and variances between classes for students' state-orientation personality were no differences [F_{seSOP} (1, 14459) = .949, $p > .05$], so as to the entire aggregation cross classes to proceeded overall test could be reasonable. Five items measured emotional SOP for students, they rated on 4-point Likert scales (1 = strongly disagree to 4 = strongly agree). Higher rating score indicated higher emotional SOP. One factor was extracted via exploratory factor analysis. The value of Kaiser-Meyer-Olkin for measurement of sampling adequacy was .901, and Bartlett's test of sphericity was significant (p = .000), both indicators underpinned the appropriateness of exploratory factor analysis. Factor loadings of five items ranged from .78 to .88, and the cumulative explanation of variance was 70.22%. The coefficient of internal consistency reliability was shown good quality (Cronbach's α = .92).

After the reliability was confirmed, confirmatory factor analysis was further introduced to examine the factor structure of the construct to provide substantial construct validity. The following cutoff criteria were used to evaluate the model fit: the goodness of fit index (GFI) ≥ .90, root-mean square error of approximation (RMSEA) ≤ .06 (Hu & Bentler, 1999), the normed fit index (NFI) ≥ .90, comparative fit index (CFI) ≥ .90, Tucker-Lewis index (TLI) ≥ .90 (Kaplan, 2009). One factor structure provided a good fit for the data [χ^2 (5, N = 14461) = 231.513 (p = .000), χ^2/df = 46.303, GFI = .998, RMSEA = .049, NFI = .997, CFI = .997, TLI = .991].

Teachers' state-orientation personality

Items asked teachers' emotional SOP was in line with students'. Higher rating score represented higher emotional SOP. One factor was also extracted via exploratory factor analysis. The value of Kaiser-Meyer-Olkin for measurement of sampling adequacy was .932, and Bartlett's test of sphericity was significant (p = .000). Factor loadings ranged from .78 to .92, and the cumulative explanation of variance was 82.12%. The coefficient of internal consistency reliability was shown good quality (Cronbach's α = .94). One factorial structure also provided a good fit to the data in measuring teachers'emotional SOP [χ^2 (5, N = 946) = 109.254 (p = .000), χ^2/df = 27.314, GFI = .998, RMSEA = .032, NFI = .998, CFI = .996, TLI = .994].

Classroom negative emotion transmission

The classroom negative emotion transmission was the mean of averaged individual negative emotions within classes. Classes were high in CNET score suggested that the negative classroom atmosphere was formed through the negative emotion transmission between students and teachers.

Mathematics achievement

Students' score of mathematics achievement were estimated by item response theory (IRT) – 3 parameter model.

3. Data analysis and model specified

Regression diagnostics were conducted to ensure the independent of residuals, and confirmed that the outlier, influential observation, and multicolinearity were not problems. Besides three discrete variables, three latent variables were mean centered to avert multicolinearity and to facilitate interpretation of the results. Four models proposed by Raudenbush and Bryk (2002) were adopted to analyze present data set by using SAS 9.3 PROC MIXED procedure, models were including (a) unconditional model; (b) means-as-outcomes model; (c) random coefficient model; (d) intercepts- and slopes-as-outcomes model. The first three models were regarded as preliminary analyses, while the last model was adopted to investigate the cross-level interactions. The analysis plans and model specifications were depicted as following.

Unconditional model

The unconditional model was used to investigate within class similarity in mathematics achievement which was known as intra-class correlation. In this model, the predicted variables were not included, and mean mathematics achievement was allowed to randomly fluctuate. Hence, there were two error terms belonged to personal and contextual level which were

denoted as r_{ij} and u_{0j} respectively. Moreover, the notations for σ^2 and τ_{00} respectively represented the variance component of r_{ij} and u_{0j}. These two variance components were introduced to calculate the intra-class correlation. The model specifications for unconditional model and equation for intra-class correlation were as following:

Equation for level 1: $Y_{ij} = \beta_{0j} + r_{ij}$

Equation for level 2: $\beta_{0j} = \beta_{00} + u_{0j}$

Combined equation: $Y_{ij} = [\beta_{00}] + [\, u_{0j} + r_{ij}]$

Equation for intra-class correlation： $\rho = \tau_{00} / (\tau_{00} + \sigma^2)$

The combined model was the sum of two equations for personal level and contextual level, and two brackets were adopted to separate fixed effect and random effect orderly. In unconditional model, there were no predicted variables, hence the similarity of mathematics achievement within class was available. The influences of contextual level predictors were further investigated by using means – as – outcomes model.

Means-as-outcomes model

This model allowed the effects of contextual level variables on mathematics achievement to be explored. In this model, the influences of two contextual level variables were introduced into model, and their importance was further investigated. The only difference between conditional and unconditional model was the addition of extra fixed and random effect terms. Specifically, teachers' emotional SOP and CNET were treated as both fixed and random effect. Moreover, variance component which was no significant in former was removed from this model. Teachers' emotional SOP and CNET were denoted as W_1 and W_2, and each of them elicited an error term u_{0j} and u_{1j} respectively.

Equation for level 1: $Y_{ij} = \beta_{0j} + \beta_{1j} + r_{ij}$

Equation for level 2: $\beta_{0j} = \gamma_{00} + \gamma_{01} W_{1j} + u_{0j}$

$\beta_{1j} = \gamma_{10} + \gamma_{11} W_{2j} + u_{1j}$

Combined equation: $Y_{ij} = [\gamma_{00} + \gamma_{01} W_{1j} + \gamma_{02} W_{2j}] + [u_{0j} + u_{1j} + r_{ij}]$

Random coefficient model

After the effects of contextual level variables were investigated, the personal level variables were incorporated into this model. The random coefficient model was introduced to investigate the differences among mean mathematics achievement of classes after controlling the effects of personal level variables. The explanatory percentage of personal level variables in individual differences of mathematics achievement was also known. The denotations of each variable were as following: gender (X_1), academic goals (X_2), attribution (X_3), and students' emotional SOP (X_{4j}). The X_1, X_2, and X_3 were fixed effects, while X_{4j} with a subscript lowercase j was denoted random effect and it was centered to the grand mean to avert multicolinearity. The model specification of random coefficient model was as following:

Equation for personal level variable: $Y_{ij} = \beta_{0j} + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 (X_{4j} - \bar{X}_j) + r_{ij}$

Equation for contextual level variable: $\beta_{0j} = \gamma_{00} + r_{ij}$

$\beta_1 = \gamma_{10} + \gamma_{11}$

$\beta_2 = \gamma_{20} + \gamma_{21} + \gamma_{22}$

$\beta_3 = \gamma_{30} + \gamma_{31} + \gamma_{32}$

$\beta_4 = \gamma_{40} + u_{4j}$

Combined equation: $Y_{ij} = [\gamma_{00} + \gamma_{10}X_1 + \gamma_{11}X_1 + \gamma_{20}X_2 + \gamma_{21}X_2 + \gamma_{22}X_2 + \gamma_{30}X_3 + \gamma_{31}X_3 + \gamma_{32}X_3 + \gamma_{40}(X_{4j} - \bar{X}_j)] + [u_{4j}(X_{4j} - \bar{X}_j) + r_{ij}]$

Intercepts- and slopes-as-outcomes model

The intercepts- and slopes-as-outcomes model was introduced to investigate the cross-level interaction between personal and contextual level variables (Hox, 2010; Raudenbush and Bryk, 2002). The personal level and contextual level variables were simultaneously incorporated into this model, which allowed cross-level interactions to be investigated. Because of many variables, the combined equation was extremely large, present study listed the equations for level 1 and level 2, the denotation of cross-level interactions was presented for exemplar. For instance, the term of X_2W_{1j} represented the cross-level interaction between academic goals and teachers emotional SOP. Consequently, the equation for intercepts- and slopes-as-outcomes model was specified as following:

Personal level equation: $Y_{ij} = \beta_{0j} + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4(X_{4j} - \bar{X}_j) + r_{ij}$

Contextual level equation: $\beta_{0j} = \gamma_{00} + \gamma_{01}W_{1j} + \gamma_{02}W_{2j} + r_{ij}$

$\beta_1 = \gamma_{10} + \gamma_{11}W_{1j} + \gamma_{12}W_{2j}$

$\beta_{2j} = \gamma_{20}W_{1j} + \gamma_{21}W_{1j} + \gamma_{22}W_{1j} + \gamma_{20}W_{2j} + \gamma_{21}W_{2j} + \gamma_{22}W_{2j}$

$\beta_3 = \gamma_{30}W_{1j} + \gamma_{31}W_{1j} + \gamma_{32}W_{1j} + \gamma_{30}W_{2j} + \gamma_{31}W_{2j} + \gamma_{32}W_{2j}$

$\beta_{4j} = \gamma_{40} + \gamma_{41}W_{1j} + \gamma_{42}W_{2j} + u_{4j}$

RESULTS

1. Descriptive Statistics and Zero-Order Correlations

The scatter plots for standardized residual versus respective predicted and explanatory variables were shown random distribution tendencies. The relationship of linearity was checked. The Cook's D statistics (ranged from 0.00001 to 0.00383) and leverage value (ranged from 0.0001 to 0.01) far smaller than the cutoff, it showed that there were no outlier and leverage points should be given additional consideration (Dielman, 2005). The multicollinearity between explanatory variables were judged from the value of tolerance and variance inflation factor (VIF), tolerance ranged from 0.93 to 1.000 and the VIF ranged from 1.000 to 1.068 demonstrated that multicollinearities were not problems.

Descriptive statistics and Zero-Order Correlations were presented in Table 1. The mean of mathematics achievement was 0.59 but the standard deviation was slightly larger. In average, students' emotional state-orientation personality was higher than teachers' (2.03 > 1.89), and the standard deviation of students' was also higher than teachers' (0.66 > 0.15).

The academic goals, attribution, SESOP correlated with mathematics achievement, while gender, TESOP, and CNET did not. There were no explanatory variables correlated with gender, and the coefficients were small. Both motivational beliefs (academic goals and attribution) correlated with each other, and the negative correlations with SESOP were observed. Only attribution showed negative correlation with CNET. The zero-order correlation among three emotional variables correlated with each other, while the correlational magnitude between two context level variables and students' level variable were higher than within two context level variables.

Table 1. Descriptive Statistics and Zero-Order Correlations Among Variables

Variables		M	SD	1	2	3	4	5	6	7
1.	mathematics achievement	0.59	1.30	-	.003	.059**	.072**	.048**	.004	.009
2.	gender	0.52	0.50		-	-.005	.001	.005	-.015	-.007
3.	academic goals	2.21	0.69			-	.079**	-.041**	.005	-.013
4.	attribution	2.55	0.70				-	-.092**	-.007	-.023**
5.	sesop	2.03	0.66					-	.342**	.249**
6.	tesop	1.89	0.15						-	-.020*
7.	cnet	2.03	0.17							-

Note. sesop = students' emotional state-orientation personality; tesop = teachers' emotional state-orientation personality; cnet = classroom negative emotion transmission. *p < .05; **p < .01

For sure, whether the difference between students' mathematics achievement and emotional SOP was simply due to different gender they were, the preliminary multivariate analyses of variance (MANOVA) were exploited. The Levene statistics was not significant, it demonstrated that the assumed homogeneity of variances was supported [$F_{math}(1,14459) = 3.44$, $p > .05$; $F_{SOP}(1,14459) = .518$, $p > .05$]. On the basis of homogeneity of variances, the inquiry of gender differences was proceeded. No significant main effects of gender revealed, in which it was congruent with latter correlation analyses, suggested that there were no gender differences existed in mathematics achievement and students' emotional SOP [$F_{math}(1,14459) = .174$, $p > .05$; $F_{SESOP}(1,14459) = .665$, $p > .05$].

2. Preliminary analyses

The between-class and within-class variance were reported in Table 2. There was a considerable variance appeared within classes in mean mathematics achievement ($\sigma^2 = 1.695$, $p < .001$), while the negligible variance between classes ($\tau_{00} = 0.003$, *ns*). It implied that there were no differences between classes achievement. It also meant that there was no similarity within classes was found in mean mathematics, even if students within class were instructed by the same teacher. Specifically, the variances in mean mathematics achievement overwhelmingly resulted from individuals

differences within classes. Furthermore, the estimated intercept was 0.586 (p < .001), it suggested that classes did not differ in their averaged mathematics achievement.

The contextual level variables (teachers' emotional SOP and CNET) were further taken into consideration to examine whether the differences remain existed on mean mathematics achievement, and to realize the decrease rate of unexplained variance resulted from the input of context level variables. The results were shown in Table 3.

Table 2. Estimated coefficient in unconditional model

Fixed effect	Coefficient
intercept (γ_{00})	0.586***
Random effect	Variance
intercept (u_{0j})	0.003
residual (r_{ij})	1.695***

***p < .001

The mean mathematics achievement decreased from 0.586 to 0.365 when two level 2 variables were taken into account. The coefficients for teachers' emotional SOP (γ_{01}) and CNET (γ_{02}) were -0.370 and -0.741 respectively. It suggested that teachers' emotional SOP within classes increased 1 point, the mean mathematics achievement decreased 0.370 points. While, the CENT increased 1 point, the mean mathematics achievement decreased 0.741 point. These results implied the large decrease which caused by level 2 emotional variables, because the value of mathematics achievement was standardized scores and large sample size. The range of 0.741 decrease contained more than 1,000 students (one-fourth of a standard deviation). Furthermore, a decrease from 1.695 to 1.063 in variance component of residual was also observed, it implied that level 2 variables: TNE and CNEA were contributed to decrease the unexplained residual variance of mean mathematics achievement within classes, and decreased proportion was 37.29% (1.695-1.063/1.695). The estimated coefficient for intercept implied that the mean mathematics achievement was 0.365 when both TESOP and CNET were at mean level.

Table 3. Estimation of coefficient and variance component for contextual level variables

Fixed effect	Coefficient
intercept (γ_{00})	0.365***
teacher emotional state-orientation personality (γ_{20})	-0.370***
classroom negative emotion transmission (γ_{30})	-0.741***
Random effect	Variance
residual (r_{ij})	1.063***

***p < .001

Table 4 reported the differences of mean mathematics achievement when personal level variables were taken into account. Owing to students' emotion SOP was centered to grand mean, the coefficient of intercept represented students whose average mathematics achievement was 0.792 when students' emotion SOP at grand mean level. Although, the main effects of personal level variables were all significant, if there were any cross-level interaction still unclear, interpreting the results of main effects herein may be less meaningful. Hence, interpretation will be given in next section.

A dramatic decrease in residual variance was observed, the value of variance component reduced from 1.063 to 0.476. It implied that personal level variables were contributed to decrease the unexplained residual variance of mean mathematics achievement between classes, and decreased proportion of unexplained residual variance was 71.92% (1.695-0.476/1.695). The personal level variables accounted for nearly twice in the proportion of unexplained residual variance than context level variables did. The personal level model explained additional 55.22% (1.063-0.476/1.063) in the proportion of unexplained residual variance by the contextual level model.

Table 4. Estimation of coefficient and variance component for personal level variables

Fixed effect	Coefficient
intercept (γ_{00})	0.792***
male (γ_{11})	0.004
vector 1 for academic goals (learning goal – lack of goal) (γ_{20})	0.053*
vector 2 for academic goals (lack of goal – lack of goal) (γ_{21})	-0.286***
vector 1 for attribution (efforts – external attribution) (γ_{30})	0.350***
vector 2 for attribution (ability – external attribution) (γ_{31})	-0.192**
sesop (γ_{40})	0.115***
Random effect	Variance
residual (r_{ij})	0.476**

Note. sesop = students' emotional state-orientation personality

*$p < .05$; **$p < .01$; ***$p < .001$

3. The interaction analyses of multiple predictors

The personal level and contextual level variables were simultaneously incorporated into intercepts- and slopes-as-outcomes model, which enable the cross-level interaction between two level variables to be further investigated, the results were shown in Table 5. No significant interactions were excluded from Table 5 as well as no significant terms in both main effect and interactions, otherwise, it would cause extremely large and complicated model.

Gender was excluded from Table 5, because no significant terms in main effect and interaction were found. Moreover, only the significant cross-level interaction of the maximum multiple-predictors (vector 2 for academic goals × vector 2 for attribution × sesop × tesop × cnet) was interpreted, due to the interpretation of lower personal level interaction (vector 2

for academic goals × vector 2 for attribution × sesop) was meaningless.

At first, the cross-level interaction of two personal level contrasts (learning goal minus social goal and efforts minus external attribution) and one contextual level variable (teachers' emotional SOP) was found ($\gamma_{20} \times \gamma_{30} \times W_1 = 1.527$, $p < .05$). It implied that the negative effect of averaged teachers' emotional SOP was inversed by students who possessed learning goal and proceeded efforts attribution, and resulted in an increase in mathematics achievement compared to students who lacked goal and proceeded external attribution. Likewise, the positive effect of the interaction of five predictors (learning goals × ability attribution × sesop × tesop × cnet) evidenced this finding ($\gamma_{20} \times \gamma_{31} \times \gamma_{40} \times W_1 \times W_2 = 4.696$, $p < .05$). It may also indicate that learning goal could compensate the potential negative effect of ability attribution, when students' and teachers' emotional SOP, and CNET were at mean level. Therefore, the inversing hypothesis was supported.

Two cross-level interaction for social goal were observed and revealed different patterns. The first one presented negative effect, it referred to students who possessed social goal and proceeded ability attribution would be influenced by theirs and teachers' emotional SOP (social goal × ability attribution × sesop × tesop = -5.076, $p < .05$). The other one revealed positive effect, it referred to students who possessed social goal and proceeded efforts attribution would not be influenced by theirs and teachers' emotional SOP and CNET which were at mean level (social goal × efforts attribution × sesop × tesop × cnet = 2.437, $p < .05$). The positive effect partly supported the minimizing hypothesis, while the negative effect also partly evidenced the reinforced hypothesis, because no gender effect emerged. It suggested that for students who possessed social goal and proceeded efforts attribution, the negative effect of mean individual and teachers' emotional SOP and CNET would be minimized, regardless of gender. Moreover, it also indicated that for students who possessed social goal and proceeded ability attribution, no matter what gender they were, would easily be influenced by their averaged emotional SOP and the averaged negative emotion transmitted by teachers.

Table 5. Estimated coefficients for cross-level interaction model

Fixed effect	Coefficient
intercept (γ_{00})	0.938**
academic goals (learning goal –lack of goal) (γ_{20})	0.173
academic goals (social goal –lack of goal) (γ_{21})	-2.734**
attribution (efforts – external attribution) (γ_{30})	1.369*
attribution (ability – external attribution) (γ_{31})	-2.041**
sesop (γ_{40})	0.113
tesop (W_1)	0.381*
cnet (W_2)	0.499*

Continuation of table 5

learning goal × efforts attribution × tesop	1.527*
social goal × ability attribution × sesop × tesop	-5.076*
lack of goal × ability attribution × sesop × cnet	-5.798*
learning goal × ability attribution × sesop × tesop × cnet	4.696*
social goal × efforts attribution × sesop × tesop × cnet	2.437*
lack of goal × ability attribution × sesop × tesop × cnet	-11.111**
Random effect	Variance
residual (r_{ij})	0.209**

Note. sesop = students emotional state-orientation personality; tesop = teachers emotional state-orientation personality; cnet = classroom negative emotion transmission.

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

The third cross-level interaction of three personal and two contextual level variables was observed (lack of goal × ability attribution × sesop × tesop × cnet = -11.111, $p < .001$). It implied that, for students who lacked explicit goal, their mathematics achievement were more likely to be influenced when they proceeded ability attribution, and theirs and teacher's emotional SOP and CNET were at mean level. Specifically, internal and external negative emotion may have greatest impact on mathematics achievement for those students who explicit lacked goal and possessed ability attribution. It was evident that the reinforcing hypothesis for explicit lack of goal and ability attribution was supported.

Notably, in the full model, the variance was reduced from 1.695 to 0.209 compared to the unconditional model, the unexplained variance decreased 87.67% when all main and interaction effects were considered. The comparisons of the four models were shown in Table 6. As it could be seen from three indexes, the smallest model indicated the best fit (Singer, 1998). The value for intercepts – and – slopes as outcomes model (full model) was smallest indicated that it could be appropriately used to interpret the effects of level 1 and level 2 on mathematics achievement. It validated the complicated inner processes behind the mathematics achievement.

Table 6. The indexes of model fit for four models

model indexes	unconditional	means –as outcomes	random coefficient	intercepts – and – slopes as outcomes
-2 Res Log Likelihood	48700.2	48706.2	48324.5	48258.5
AIC (smaller is better)	48704.2	48708.2	48326.5	48260.5
BIC (smaller is better)	48713.9	48715.8	48331.4	48268.1

DISCUSSION

The main purpose of present study was to examine the effects of the interactions between context level and personal level variables on mathematics achievement. In addition to interactions, multilevel analysis was also adopted to examine similarity in averaged mathematics achievement within and between classes. Most importantly, three hypotheses of cross-level interaction were tested in the last model which took physiological, psychological trait and contextual effects into account.

There were no differences existed in averaged mathematics achievement between classes, it also represented that no obvious similarities revealed within classes. The considerable variability was caused by individual differences within classes, even if students in each class were taught by the same teacher. It suggested that teachers had difficult in teaching mathematics, even had no contribution on minimizing the differences of mathematics achievement in Taiwan. This phenomenon may be resulted from normalized constitution of students within classes, since the large gap in mathematics achievement had already existed when they initially enrolled in the classes. This result suggested that the policy with respect to randomly assigned students to different classes in enrollment should be further reflected.

In first conditional model - means-as-outcomes model, negative effects of class level negative emotion were observed. The 37.29% unexplained residual variance were explained when two class level variables were taken into consideration. It meant that they contributed to interpret the considerable variance of individual differences of mathematics achievement within classes. In addition, personal level variables in random coefficient model contributed to explain additional 55.22% variance in remaining unexplained residual variance by level 2 variables. It reflected the important influence of personal level variables besides gender on mathematics achievement. The main effect of gender and its interaction among other variables were not significant in influencing mathematics achievement, this result was congruent with Else-Quest et al. (2010)'s contention.

Since the main effects of personal and contextual level variables were all significant, it was proposed that they were all important in explaining the variance of mathematics achievement. Hence, these variables may have not only statistic but practice meanings. Specifically, in order to enhance mathematics performance, teachers had to simultaneously concern emotional state of themselves and students, and understood what reasons students engaged in learning and how they ascribed their success/failure experience. Moreover, the gender stereotype in mathematics achievement grounded in tradition society should be discarded, because the main and interaction of gender were not found, it evidenced present contention.

The interaction among students' and teachers' emotional SOP and CNET was emerged. It implied that students' emotional SOP may interplay with teachers' negative and emotional SOP, and had joint effect on the formation of CNET. But, the effects merely worked on part of students. The cross-level interactions were supported present hypotheses at different extent. The inversing hypothesis was supported, it implied that for students who stressed on mastering learning task, the effects of individual and others negative emotion on mathematics achievement will be inversed regardless of gender and attribution. It may suggest that learning goal would protect students from the detrimental effects of ascribing failure to ability and potential negative effect of emotional SOP from themselves and teachers and contextual negative

emotion. Such that, they may keep attention on learning tasks, and resulted in higher mathematics achievement than other students. This result was in line with Pekrun et al. (2009)'s findings, which referred to the effect of learning goal on enhancing positive emotion (e.g. enjoyment) and inhibiting negative emotion (e.g. anxiety). Even if negative emotion produced or introduced, the learning goal may keep students' motivation and conduct them toward the way to mastering task. As a result, they could outperform others when students all suffered from the influences of negative emotion.

There was still an interesting finding for students who possessed learning goal, it indicated that students proceeded ability attribution perform better than those who proceeded efforts attribution, when they encountered internally and externally negative emotional event. It suggested that for students who possessed learning goal would be more likely to strive to maintain positive and avoid negative evaluation to their ability. Hence, it may be possible that learning goal inversed the negative effects of negative emotion, and ability revealed motor to maintain their volition toward getting good grades.

Second, present study postulated that girls who possessed social goals and proceeded efforts attribution, the mathematics achievement would be influenced slightly by individuals' and teachers' emotional SOP and CNET. This result did not completely as expect, because gender effect was not found, the minimizing hypothesis was partly supported. In addition, reinforcing hypothesis for social goal, assumed that for boys who possessed social goal and proceeded ability attribution would be more likely influenced by others and contextual negative emotion. It also partly supported because no gender effect revealed. It was interesting that there were two different patterns for students who possessed social goal. The positive effect may suggest that boys and girls were identically regarded efforts as virtue which could comply with others expectation. For this social reason, they would try to meet or accomplish others demand, they would like to devote their efforts and persist engaging in learning activity. Finally, it may be also resulted in good performance, but may not lead them to outperform than those who possess learning goal because they were regarded less interested in the learning task than those who possessed learning goal.

In addition, the negative effect for social goal may imply that students viewed teachers' negative emotion as negative feedbacks to their ability. Hence, when they strove to perform for others praises, negative feedbacks had harmful effects on their subsequent achievement performance. Because the social goal was based on the sense of relatedness rather than competence suggested by Ryan and Deci (2000). In practice, teachers had to help students to well set up the interpretation for others negative emotion and attribution, especially for those who regarded the relatedness was important to them.

Students who lacked goal were considered negatively correlated to intrinsic motivation (Reinhard et al., 2010). As for students who possessed lack of goals and proceeded external attribution were most likely influenced by individual and others negative emotions. It implied that students may tend to regard these negative feedbacks as the sources of attribution, and they were more likely to be influenced, especially when there was no explicit goal to direct their motivational belief, their behavioral intention could not be urged and maintained toward success.

In summary, the effect of physiological character (gender) may be less important in interpreting the difference of mathematics achievement. More sophisticated interpretation of psychological processes may be needed, because of the nature of multi-dimensional education. The cross-level investigation of the multiple predictors led us to gain more precise

and deeper insight in interpreting explicit learning outcomes. Teachers' instruction may have limited contributions on shrinking the gap of mathematics achievement and promoting students' academic knowledge or achievement without taking students' psychological states into account. Teachers also required considering their own and classroom negative emotions, because personal and contextual psychological may have joint effects on mathematics achievement. Specifically, effects of the same negative emotions may be inversed by someone, minimized by another, or reinforced by the other, because diverse motivational beliefs they trusted. Hence, it may shed valuable light on that the instructions for students' attitude may be more important than knowledge content. In other words, students need to endorse positive academic goals and attribution, and to proceed positive interpretation for themselves and others negative emotions. If this was the case, their achievement performance may be subsequently enhanced. Further, the goal of physiological and psychological health may be achieved as well as the attainment of achievement.

CONCLUSION

Academic achievement was resulted from sophisticated psychological and contextual interaction. Investigation based on more explanatory variables may be pivotal, the within interaction let us gain better understandings in psychological process within person. While cross-level interactions between personal and contextual level variables deepen our insights on the basis of the understandings derived from individual psychological processes. Moreover, transmission of negative emotions may happen between teacher and students which may cause variant differences in mathematics achievement from person to person depended on different psychological states. Considerable variance of residual was explained by two emotional variables in contextual level as well as personal level variables, their importance was proved. These results may suggest that affectional or attitudinal instructions had to be respected in high schools education. Last but not least, teachers ought to realize what the academic goals students possessed, and assisted them in redirecting appropriate reasons for pursuing mathematics achievement according to their psychological needs.

Limitations and Future Directions

Our findings must be interpreted in the context of several limitations. First, present research was a concurrent design; therefore, consideration had to be taken to interpret the results in terms of associations rather than causal relationships. This consideration highlights the need to attend to reciprocal influences of psychological states and contextual characters on mathematics achievements.

Second, three nominal variables and three latent variables reported by students were used in present study. Two of three nominal variables – academic goals and attribution, classified students into three groups respectively. In fact, other finer classifications may be possible, and "yes or no" measurement may not fully guarantee their psychological status which they actually possessed. But, present study remained providing worthily referable findings due to representative sample. Moreover, aggregated negative emotion was used to represent emotional state-orientation personality rather

than using single negative emotion such as depression, because negative emotion may be not operate independently, but intertwined in some manner. Hence, there may be additive effects of different negative emotion, it meant that other patterns of negative emotion were also possible.

Third, the generalizability of the current results beyond adolescents in high school mathematics classes was currently unknown. In addition, samples comprised of Taiwanese students, and some researchers have raised the possibility that some psychological traits such as academic goals may operate differently in different cultures (Urdan and Mestas, 2006). Therefore, generalized results to other cultures may be given additional concerns on cultural differences.

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