Academic Self-Concept, Autonomous Academic Motivation, and Academic Achievement: Mediating and Additive Effects

Frédéic Guay, Catherine F. Ratelle, Amélie Roy, and David Litalien

Faculty of Educational Sciences, Laval University

This is the prepublication version of the following manuscript:

Guay, F., Ratelle, C. F., Roy, A., & Litalien, D. (2010). Academic self-concept, autonomous academic motivation, and academic achievement: Mediating and additive effects. *Learning and Individual Differences*, *20*(6), 644-653.

Acknowledgements: This work was supported by the Canada Research Chair Program. We would like to thank Simon Olivier Fournier for performing the statistical analyses.

Corresponding author :
Frédéric Guay
Département des fondements et pratiques en éducation
Faculté des Sciences de l'Éducation, Université Laval, Québec (Québec) G1V 0A6, Canada.
Tel : +1 418 656 2131; fax +1 418 656 2885
E-mail : frederic.guay@fse.ulaval.c

Abstract

Three conceptual models were tested to examine the relationships among academic self-concept, autonomous academic motivation, and academic achievement. This allowed us to determine whether 1) autonomous academic motivation mediates the relation between academic self-concept and achievement, 2) academic self-concept mediates the relation between autonomous academic motivation and achievement, or 3) both motivational constructs have an additive effect on academic achievement. A total of 925 high school students (404 boys and 521 girls) were asked to complete a questionnaire on two occasions separated by a year interval. Results from SEM analyses provided good support for the hypothesized model positing that autonomous academic motivation mediates the academic self-concept-academic achievement relation. Results are discussed in light of self-determination theory and self-concept theory.

Keywords: academic self-concept, autonomous academic motivation, academic achievement, structural equation modeling

The question as to whether motivation predicts student academic achievement is important in educational psychology. Interest in this issue has grown among education researchers and school professionals because student motivation can change with environmental and interpersonal factors. That is, parents, teachers, and other school professionals can create the conditions for student motivation to flourish (Reeve, 2002) and have the potential to improve their academic performance. Until now, studies on the linkages between academic motivation and academic achievement have used diverse theoretical approaches such as achievement goals (Wolters, Yu, & Pintrich, 1996), intrinsic motivation (Goldberg & Cornell, 1998), competence beliefs (Guay, Marsh, & Boivin, 2003), value attribution/control beliefs (Denissen, Zarrett, & Eccles, 2007; Stupnisky et al., 2007), and interests (Marsh, Trautwein, Lüdtke, Köller, & Baumert, 2005).

In this study, we explored two motivational factors that have repeatedly been associated with academic achievement, namely autonomous academic motivation (see Guay, Ratelle, & Chanal, 2008, for a review) and academic self-concept (see Marsh, 2007, for a review). Specifically, we examined the relations among academic self-concept, autonomous academic motivation, and academic achievement by contrasting three conceptual models. This allowed us to determine whether 1) autonomous academic motivation mediates the relation between academic self-concept and achievement, 2) academic self-concept mediates the relation between autonomous academic motivation and achievement, or 3) both constructs have additive contribution to the prediction of achievement. Testing the relations among these constructs is especially important as research on academic self-concept has developed almost independently of research on autonomous academic motivation, with few studies connecting the two constructs. In this study, we attempt to answer these questions by means of a longitudinal study using a structural equation modeling (SEM) framework. We begin by defining the constructs of academic self-concept and autonomous academic motivation. We then present three conceptual models that can explain the relations among these constructs.

Academic Self-Concept and Achievement

Academic self-concept is an evaluative self-perception that is formed through the student's experience and interpretation of the school environment (Marsh & Craven, 1997; Shavelson, Hubner, & Stanton, 1976). Determining the direction of the relation between academic self-concept and academic achievement has been a critical issue in this field of research. Research has contrasted the self-enhancement and skill development models (Calsyn & Kenny, 1977). According to the self-enhancement model, self-concept is a determinant of academic achievement, whereas the skill development model proposes that academic self-concept is a consequence of academic achievement. In past research, these models were tested using the magnitude of cross-lagged relations to determine the *potential* causal predominance between the two variables. In other words, effect sizes of prior achievement on subsequent self-concept (in support of skill development models) were compared with effect sizes of prior self-concept on subsequent achievement (in support of self-enhancement models).

According to Marsh and his colleagues (see Marsh, Byrne, & Yeung, 1999) comparing these effects to support either model is inadequate. A more realistic compromise between the self-enhancement and skill development models would be a reciprocal-effects model, whereby prior self-concept predicts subsequent achievement and prior achievement predicts subsequent self-concept. Marsh and Yeung (1998) reviewed the literature on this reciprocal relation and concluded that, despite some methodological limitations and heterogeneity in terms of design, age, and sample, the research consistently supported a reciprocal relation between these variables (see also Marsh, 2007, for a review). In addition, past research has shown that the reciprocal relation between these constructs is observed with a general measure of academic self-concept (e.g., Guay, Marsh, Boivin, 2003) as well as with one that is specific to a given school subject (e.g., Marsh et al., 2005). Thus, global or specific academic self-concept would contribute to academic achievement, which would in turn enhance academic self-concept, and so on.

In examining these reciprocal relations, we wondered whether other variables were involved. We propose that motivation is the process that explains how academic self-concept contributes to achievement, which is consistent with expectancy-value theory (Wigfield & Eccles, 2000), self-concept theory (Harter, 1999; Marsh, 2007), and self-determination theory (SDT; Deci & Ryan, 1985). However, few studies have examined the mediating role of academic motivation in the relation between academic self-concept and achievement. The goal of the present study was to test this mediating effect from a self-determination perspective of academic motivation.

Autonomous Academic Motivation and Achievement

SDT proposes that there are different types of motivation, reflecting different levels of self-determination (i.e., the extent to which behavior originates from the self; Deci & Ryan, 1985). *Intrinsic motivation* is the most self-determined form of motivation and it occurs when a person engages in an activity for its own sake, for the pleasure and satisfaction derived from it. Of course, not all behaviors are intrinsically motivated, some are extrinsically motivated. Extrinsic motivation involves engaging in an activity as a means to an end rather than for its intrinsic qualities. According to SDT, there are several types of extrinsic motivations, differing in their underlying level of self-determination. From the lowest to highest levels of self-determination, the different types of extrinsic motivation are external regulation, introjected regulation, identified regulation, and integrated regulation. *External regulation* refers to behaviors that are not self-determined, being regulated by external means such as rewards and constraints. Regulation is *introjected* when behaviors are partly internalized, but this internalization is not coherent with other aspects of the self. For example, individuals can act in order to rid themselves of guilt, lessen anxiety, or maintain a positive self-image. *Identified regulation* occurs when behaviors are performed by choice, because the individual considers them to be important. For example, a student might not enjoy college, but decides to pursue a college education because it is an important step toward entering the job market in a desired field. According to SDT, an external source of motivation can progressively transform into an identified regulation (personal value) through the process of internalization. When a behavior that was initially externally motivated becomes regulated by identification, it becomes as effective as intrinsically motivated behaviors in producing positive outcomes. Finally, *integrated regulation* occurs when identified regulations are congruent with the individual's values and needs. However, this form of regulation was not addressed in this study. A final type of motivation posited by SDT is *amotivation*, characterized by a lack of intentionality, and therefore a relative absence of motivation (whether intrinsic or extrinsic). Amotivated individuals experience feelings of incompetence and lack of control.

Past research on SDT has distinguished between motivations that are autonomous (intrinsic motivation, identified regulation), controlled (introjected and external regulations) and amotivated. These scores have been used by SDT researchers to calculate a relative autonomy index (RAI), which captures individuals' level of autonomous motivation relative to their level of controlled motivation or amotivation (e.g., Guay, Mageau, & Vallerand, 2003; Hein & Hagger, 2007; Niemiec, Lynch, Vansteenkiste, Bernstein, Deci, & Ryan, 2006; Ratelle, Larose, Guay, & Senécal, 2004; Vallerand, Fortier, & Guay, 1997). This measure is typically used in the context of large and complex models because it reduces the number of variables being assessed, thereby increasing the model's parsimony. In the present context, a high positive score on the RAI indicates that the student is motivated to attend school by autonomous reasons (e.g., because it's fun, because it's important) more than by controlled or amotivated ones (e.g., because he feels coerced to go, because his parents reward him for going).

Recently, Guay et al. (2008) reviewed the research on the relation between autonomous academic motivation (i.e., a global measure) and academic achievement and concluded that there is some support for the fact that prior autonomous academic motivation predicts subsequent academic achievement (see also Guay & Vallerand, 1997). However, they underscored the scarcity of longitudinal studies using a repeated measures design to test this relation.

Relations between Academic Self-Concept, Autonomous Academic Motivation, and Achievement

Figure 1 presents three conceptual models that represent the relations among the variables under study. The first model, which is based on SDT and self-concept theory (Marsh, 2007), proposes that autonomous academic motivation mediates the contribution of academic self-concept to academic achievement (see Figure 1a). That is, because they feel competent when performing academic tasks, students will experience an increase in autonomous academic motivation, which will make them achieve higher scores on their assignments and exams. Some cross-sectional and longitudinal studies have provided preliminary support for this model (e.g., Fortier, Vallerand, & Guay, 1995; Guay & Vallerand, 1997). For example, Guay and Vallerand (1997) have shown, using a half-longitudinal design and general measures of self-concept, autonomous academic motivation (i.e., not specific to school subjects), and grades, that autonomous academic motivation (as assessed by the RAI) mediates the academic self-concept – academic achievement relation.

Other studies have tested this meditational model for conceptually-related constructs, namely academic interests and academic intrinsic motivation. Indeed, as stated above intrinsic motivation is included in the calculation of the RAI and some studies (see Guay et al., 2008) have shown that intrinsic motivation and autonomous academic motivation might have similar patterns of findings when predicting school outcomes. Marsh et al. (2005) conducted two longitudinal studies to verify whether interest toward math mediates the relation between math self-concept and grades in math. The results of their cross-lagged SEM analyses supported a reciprocal relation between math self-concept and grades. In addition, their results provided some support for a reciprocal relation between math interests and self-concept. However, the cross-lagged relations between math interests and grades were not significant. Using measures that are not specific to a given school subject, Goldberg and Cornell (1998) observed similar relations using intrinsic motivation, autonomous judgment, and perceived competence (a concept akin to self-concept) as predictors of academic achievement. Specifically, cross-lagged longitudinal analyses indicated that prior self-concept predicted subsequent academic achievement rather than the reverse. However, whereas the association of prior achievement to subsequent self-concept was not significant, prior achievement predicted subsequent intrinsic motivation and autonomous judgment. Neither intrinsic motivation nor autonomous judgment predicted subsequent academic achievement, although both variables predicted academic self-concept. Marsh et al. (2005) and Goldberg and Cornell (1998) studies are interesting for several reasons. Although they have used different measures (intrinsic motivation vs. interests, perceived competence vs. self-concept) at different levels of specificity (school subject-specific vs. school in general) they come to similar conclusions.

The evidence in support of the first model is therefore mixed. When the RAI is used to capture autonomous academic motivation, the mediation model of autonomous academic motivation holds, but when other, similar constructs (i.e., intrinsic motivation and interest) are used, it is not supported. In addition, it should be noted that Marsh et al. (2005) and Goldberg and Cornell (1998) used sophisticated longitudinal designs, whereas studies that focused on autonomous motivation per se did not (e.g., Guay & Vallerand, 1997). Thus, we need to test whether autonomous academic motivation remains a significant mediator when more rigorous analyses and longitudinal design are applied.

The second posits that academic self-concept plays a meditational role between autonomous academic motivation and achievement (see Figure 1b). That is, because students who are autonomously motivated may be more proactive at school, they will develop a positive academic self-concept, and consequently improve their grades. Very few studies have tested this model, although Guay, Boggiano, and Vallerand (2001) showed in a longitudinal study that academic intrinsic motivation predicted subsequent academic self-concept, whereas prior academic self-concept did not predict subsequent academic intrinsic motivation. However, their study entails some weaknesses: analyses were based on simple regression equations alone, the sample size was small, and academic achievement was not assessed. Nevertheless, we may argue that the previously mentioned results of Marsh et al. (2005) and Goldberg and Cornell (1998) support for the mediation model of academic self-concept. In fact, these studies found that prior academic interests or intrinsic motivation predicted subsequent self-concept, which itself predicted subsequent achievement.

The third model is consistent with Connell and Wellborn's (1991) model of self-system processes, and posits that students need to perceive themselves as competent (i.e., academic self-concept) and be autonomously motivated to achieve good grades (i.e., an additive model; see Figure

1c). Grolnick, Ryan, and Deci (1991) tested this additive model using a cross-sectional design. Results from SEM analyses showed that both perceived academic competence (or self-concept) and autonomous academic motivation were associated with academic achievement, as measured by grades and standardized achievement scores. It is important to note that in Grolnick et al.'s (1991) study, the contribution of perceived academic competence ($\beta = .28$) was significantly higher than that of autonomous academic motivation ($\beta = .07$; $t\ [453] = 3.79$, $p < .01$). In a study by Spinath, Spinath, Harlaar, and Plomin (2006), when intelligence, intrinsic value, and perceived ability were entered simultaneously into a regression analysis, only intelligence and perceived ability in Math and English predicted Math and English grades. Although they did not control for intelligence, Grolnick and Slowiaczek (1994) found similar results: perceived academic competence predicted school grades, whereas autonomous academic motivation did not. From these research findings, we can conclude that the evidence in support of the additive model is mixed.

In sum, previous studies did not unequivocally support one model over the others. When the RAI score is used as a measure of autonomous motivation, the mediation model of autonomous academic motivation appears to prevail. However, when interest or intrinsic motivation are used, the mediation model of academic self-concept is supported with either general or subject-specific measures. It should be noted that the design used in studies providing credence to the mediation model of academic self-concept is more rigorous than those used to support the mediation model of autonomous academic motivation. In order to alleviate this limitation, the three models will be tested by means of a longitudinal design using a structural equation modeling (SEM) framework.

A Structural Equation Modeling (SEM) Framework for Testing Mediation Models with Longitudinal Data

Cole and Maxwell (2003) have proposed different steps to test mediation models with longitudinal data involving at least three measurement occasions. Because this study contains only two measurement occasions, we have slightly adapted those steps. The first step tests the adequateness of the measurement model. That is, without an adequate measurement model, testing mediating models could be dubious. The second step verifies the invariance of factor loadings over time. Having factor loadings that are not equivalent across measurement times implies that participants do not understand the construct in the same way from one year to the next, which could compromise the interpretations of the observed effects. The third step allows verifying if unmeasured variables can explain some of the relations among variables included in the model. This test implies the comparison of a full model to a reduced model. The full model contains the following parameters: a) exogenous variables have direct effects on endogenous variables, b) exogenous variables are correlated, and c) endogenous variables are correlated. The reduced model is identical to the full model except that endogenous variables are no longer correlated. If the reduced model differs from the full model, one can conclude that unmeasured variables might explain the relations among endogenous variables, which may lead investigators to search for other potential predictors. The fourth step verifies if other models can explain the relations among constructs of interest in a more parsimonious way than the full model. This step will be achieved by only keeping paths from the full model that are included in the three conceptual models presented in Figure 1. Specifically, Cole and Maxwell (2003) recommend a pair of longitudinal tests where a) the Time 1 independent variable predicts the Time 2 mediator (path a) while controlling for the Time 1 mediator, and b) the Time 1 mediator predicts the Time 2 dependant variable (path b) while controlling for the Time 1 dependant variable.

Method

Participants and Procedure

In fall 2004 (Time 1; T1), 925 high school students (404 boys and 521 girls) completed a questionnaire in class. Mean age of the participants was 13.76 years ($SD = 1.10$) and 91% were born in the province of Quebec. In fall 2005 (Time 2; T2), a web questionnaire was sent to all participants and completed by 828 of them, for a 90% response rate. In the statistical analyses section, we address the issue of missing data.

Measures

Academic self-concept. The Perceived Competence Scale, developed in French by Losier, Vallerand, and Blais (1993), was used to measure academic self-concept. This instrument used a 7-point scale and included four items (i.e., "I have trouble doing my schoolwork properly" – reverse scoring; "As a student, I have developed very good competencies; I do not believe that I am a very talented student" – reverse scoring; "Overall, I think that I am a good student"). Cronbach alphas for this measure were .78 and .74 for T1 and T2, respectively. These scores were highly correlated (above .54) with student grades obtained from official report cards. These correlations are consistent with the findings of previous studies on the relation between academic self-concept and academic achievement (Guay et al., 2003).

Autonomous academic motivation. The Academic Motivation Scale (AMS; Vallerand, Blais, Briere, & Pelletier, 1989) was used to assess students' motivation toward school activities. The AMS is composed of seven subscales containing four items each. Each item represents a possible reason (or motivation) for attending school. Three subscales assess three types of intrinsic motivation: knowledge, accomplishment, and stimulation. Three subscales assess three types of extrinsic motivation: identified, introjected, and external regulation. Finally, the seventh subscale assesses amotivation. Items were scored on a 7-point Likert scale. To reduce the length of the questionnaire, students did not complete all subscales but only the following: intrinsic motivation for knowledge, identified regulation, introjected regulation, external regulation, and amotivation, resulting in a 20-item scale (four items per subscale). As mentioned earlier, we used the RAI to reduce the number of variables assessed in our model. In line with previous research (e.g., Guay et al., 2003; Ratelle et al., 2004; Vallerand et al., 1997), the RAI was computed by assigning to each motivation subscale a weight that represents its amount of self-determination. Consequently, positive weights were placed on autonomous forms of motivation and negative weights on controlled motivations or amotivation. Hence, a weight of +2 was assigned to the intrinsic motivation score because it represents the most self-determined form of motivation. A weight of +1 was assigned to the identified regulation score because it is a self-determined form of motivation, although not as much as intrinsic motivation. For introjected and external regulations, a weight of -1 was assigned to them because these are controlled forms of motivation. Finally, a -2 weight was assigned to the amotivation score because it is the less self-determined form of motivation. The following formula was used: (2*intrinsic motivation + identified regulation) – ((introjected regulation + external regulation)/2 + 2*amotivation)). Cronbach alphas for the various AMS subscales across measurement times ranged from .72 to .91.

Academic achievement. A cumulative measure of academic achievement was obtained from the official school transcripts for each of the two school years. Grades are usually reported in percentages in the Quebec educational system. To obtain a cumulative measure of achievement for a given school year, the school administration simply computed students' grades in various school subjects for the entire school year.

Statistical Analyses

Goodness of fit. All structural equation modeling analyses were performed on covariance matrices using Mplus (version 5; Muthén & Muthén, 2007) with the maximum likelihood estimation procedure. To evaluate model fit, we used the Comparative Fit Index (CFI), the Tucker-Lewis Index (TLI), the Root Mean Square Error of Approximation (RMSEA), and the chi-square test statistic (the robust version because the data were not normally distributed). The NNFI and CFI vary along a 0-to-1 continuum where values greater than .90 typically represent an acceptable fit (Schumacker & Lomax, 1996). Browne and Cudeck (1993; also see Jöreskog & Sörbom, 1993) suggest that RMSEA values lower than .05 indicate a close fit and that values up to .08 represent reasonable errors of approximation. However, Hu and Bentler (1999) called for more stringent cutoff values for goodness of fit indices, such as .95 for the CFI and NNFI and .06 for the RMSEA.

Correlated uniquenesses. In line with Marsh and Hau (1996), our SEM models estimated correlated uniquenesses between the same constructs measured on the two occasions to reduce method/halo effects. In the present study, the models that estimated correlated uniquenesses fitted the data significantly better than models that did not. In addition, two correlations involving items for academic self-concept within a specific measurement time were estimated ($r_{(item1, item3)}$, $r_{(item2, item4)}$). Based on our preliminary analyses, and in order to facilitate interpretation of the results, we focus our discussion on models with correlated uniquenesses.

Missing data. The descriptive analyses indicated that, of the initial sample of 925 participants at T1, 828 (90%) completed the second data wave. Although small, this loss of participants can bias the results, because the participants who did not complete the second questionnaire may have particular characteristics that may undermine the validity of the study.

We tested whether the participants who completed the two data waves were equivalent to those who provided data at T1 only. A MANOVA was performed to test the main effects of participation groups (1 wave vs. 2 waves) on the 25 indicators of the latent constructs at T1. The results revealed a significant multivariate difference between the two groups (F [25, 815] = 1.94, $p < .05$). It is important to note that of the 25 indicators, eight presented a significant effect (30%). Of these significant effects, only one explained more than 1% of the variance. Specifically, students who participated at both waves had higher grades (M = 72.29) than students who only participated at T1 (M = 67.31). Given these differences, we have decided to correct these potential biases by estimating missing observations instead of using a "Listwise" deletion of missing cases. Several researchers have shown that this latter method, as well as other ad hoc methods such as mean substitution, are inappropriate for dealing with missing data (Davey, Shanahan, & Schafer, 2001; Peugh & Enders, 2004). In the present study, the Full Information Maximum Likelihood (FIML) approach was used to estimate missing values. This data handling method rebuilds the covariance matrix and the sample mean estimates, and many studies have suggested that it generally produces the least biased and most efficient parameter estimates (Peugh & Enders, 2004).

Results

Step 1: Test of the Measurement Model

Means, standard deviations, and minimum and maximum values for all variables are presented in Table 1. Model 1, which verified the adequacy of the measurement model, yielded adequate fit indices (see Table 2), thereby providing good support for the fact that the indicators relate to one another in the ways prescribed by the measurement model. Correlations among latent constructs are presented in Table 3. The three autocorrelations indicated that all constructs were stable over time (*rs* > .50). Correlations indicated that academic self-concept and autonomous academic motivation were moderately related, and that academic self-concept appeared to be more strongly correlated (both cross-sectionally and longitudinally) with achievement than was autonomous academic motivation. However, these relations were liable to differ when testing the models proposed in Figure 1, because they take into account the unique contributive effect of the independent variable on the dependant variable.

Step 2: Tests of Equivalence of Factor Loadings

Model 2 tests the invariance of factor loadings across measurement times. Fit indices of Model 2 were adequate, but this model did differ from Model 1, thereby indicating that the meaning of the constructs slightly changed over time. Inspection of statistical tests revealed that two loadings of the autonomous motivation latent construct were not invariant through time (loadings 2 and 4). However, fit indices (CFI, TLI, and RMSEA) of Model 1 and 2 were nearly identical. Given that differences appear to be inconsequential in terms of model adequateness, we have decided to fix all loadings to equality.

Step 3: Test of Added Components

In Model 3, all factor loadings were fixed to equality over time. In addition, Model 3 tested all possible paths among exogenous and endogenous variables as well as correlations among exogenous variables and correlations among disturbances (see Figure 2). Model 4 was identical to Model 3, except that correlations among disturbances were not estimated. Model 3 and 4 offered good fit indices (see Table 3). However, Model 3 offered a better fit to the data than Model 4, thereby indicating that variables not included in the model could explain some of the relations among variables included in the model. This result will be discussed more extensively in the discussion section.

Step 4: Test of Omitted Paths

In this final step, we tested three models and compared them to the full model (Model 3). Model 5 tested the mediation model of autonomous academic motivation (see Figure 3). Model 6 verified the mediation model of academic self-concept (see Figure 4), whereas Model 7 tested the additive model (see Figure 5). Model 6 and 7 differed significantly ($p < .01$) from Model 3 whereas Model 5 did not differ, which indicated that this more parsimonious model fitted the data best (see Table 3). Based on these results, we kept Model 5 as the best model and based our interpretations on it.

In Model 5, the path connecting T1 academic self-concept to T2 autonomous academic motivation was positive (β=.16; $p < .05$) as well as the one connecting T1 autonomous academic motivation to T2 academic achievement (β=.14; $p < .05$). Consistent with mediation principles, the path connecting T1 academic self-concept and T2 academic achievement was nonsignificant (β=-.001), but in a subsequent model (Model 8; see Table 3), this path was significant (β=.15) when other cross-lagged paths included in model 5 were fixed to 0. The Sobel's (1982) test of the indirect effect (a*b) was not equal to 0 (ab = 0.184, S.E. = 0.074, p = 0.013). These findings thus provide good support for the mediation model of autonomous academic motivation.

Discussion

The purpose of this study was to test three conceptual models describing the linkages between academic self-concept, autonomous academic motivation, and academic achievement. The first model posited that autonomous academic motivation mediates the relation between academic self-concept and achievement. The second model posited that academic self-concept mediates the relation between autonomous academic motivation and achievement. The third model proposed that autonomous academic motivation and academic self-concept have additive contributions in predicting achievement. Testing these models is especially important as research on academic self-concept has developed almost independently of research on autonomous academic motivation, with few studies connecting the two constructs. The results of the SEM analyses provided stronger support for the first model than for the other two. Below, we discuss theoretical and practical implications for these results as well as the limitations of the study and avenues for future research.

Implications

A first implication of our findings pertains to the role of autonomous academic motivation in the relation between academic self-concept and achievement. In our study, we found that autonomous academic motivation mediated this relation, such that students who perceived themselves as academically competent obtained higher grades because their academic self-concept led them to be more autonomously motivated at school. These findings are consistent with SDT (Deci & Ryan, 1985, 2002), which proposes that perceiving oneself as competent (i.e., having a positive academic self-concept) increases autonomous academic motivation, especially when people perceive an internal locus of causality (i.e., they feel that they perform a given behavior without any internal or external pressure). In such cases, positive outcomes are observed, including higher achievement. In a similar vein, Vallerand's (1997) hierarchical model of intrinsic and extrinsic motivation posits that autonomous motivation explains why competence (or positive self-concept) can predict positive outcomes such as achievement. Our findings on the mediating role of autonomous motivation in the relation between self-concept and achievement are thus consistent with this theoretical model.

Second, our results also have implications for the findings of Marsh and his colleagues (2005), who found that academic interests (a concept akin to autonomous motivation) did not mediate the relation between academic self-concept and subsequent grades. One reason for this apparent contradiction is the exact nature of the mediating variable. Whereas Marsh et al. focused on academic interests, or the intrinsically motivating aspect of autonomous motivation, our measure involved a more complex motivational spectrum encompassing intrinsic motivation, identified regulation, introjected regulation, external regulation, and amotivation. It is therefore possible that, from a motivational point of view, intrinsic motivation and awareness of the importance of the academic task are two optimal but distinct prerequisites for student achievement in high school. In fact, in schools where extrinsic contingencies and constraints are salient (e.g., few opportunities for course selection, competition, etc.), students may realize that an educational task is boring but nonetheless believe it to be important. This realization may help them persist irrespective of whether or not the task is interesting (see also Ratelle, Guay, Vallerand, Larose, & Sénécal, 2007). Similar findings with respect to motivation toward the environment were reported by Koestner and Losier (2002). Another explanation for the divergent results observed may stem from the fact that Marsh et al. (2005) evaluated academic self-concept and interests toward a specific school subject (math) whereas, in this study, we have assessed autonomous academic motivation and academic self-concept in a general way (school level). Though this may be a valuable explanation, it is important to keep in mind that previous studies have reported similar findings for specific and global measures (Goldberg & Cornell, 1998; Guay et al. , 2003). Consequently, we believe that the mixed findings observed are not du to the specificity of the measures, but rather to the nature of the construct.

Third, some might argue that our pattern of correlations suggests that the proximal predictor of grades is not autonomous academic motivation but rather academic self-concept. In fact, the longitudinal and cross-sectional correlations indicated that academic self-concept was more strongly correlated with academic achievement. What is important to consider, however, is the final model, which controlled for shared variance between academic self-concept and autonomous academic motivation. In this model, only the unique variance of autonomous academic motivation predicted academic achievement, and the portion of competence that was independent from autonomous motivation was not a significant predictor of academic achievement.

Finally, our model comparison (Model 3 vs. Model 4) revealed that some variables outside the model could explain some of the relations among variables included in the model. Related to this point, SDT (Deci & Ryan, 2002) proposed that in addition to perceived competence (or self-concept), perceived relatedness (feeling connected to others, to caring for and being cared for by those others), and perceived autonomy (acting volitionally, in line with who we are) are two important predictors of autonomous academic motivation. It would be thus important in future research to include those variables in the prediction of academic achievement.

Limitations

In interpreting these findings, it is important to consider the limitations of this study. First, there is some controversy surrounding the possibility that SEM longitudinal analyses capture potential “causal processes”, because a third variable can explain the relations between the variables (Cole & Maxwell, 2003). Although most third-variable problems can be resolved by incorporating appropriate measures of these potentially problematic influences into structural equation models, it is impossible to collect the measures of all potential third variables, such that this alternative explanation will always threaten the validity of interpretations. We can therefore not conclude that the relations among variables included in our model are causal.

A second limitation concerns the pattern of missing data. While estimates of missing values are preferable to case deletion, the fact that some differences were observed between participants who completed both questionnaires and those who completed a questionnaire at T1 only might have biased our results. These findings should thus be replicated to increase their validity.

In addition to the above suggestions, future research should test these effects at different developmental stages. While we would expect the academic self-concept → autonomous academic motivation → achievement sequence to consolidate in later years (e.g., during college or university), we are not sure when in childhood this sequence begins to develop. Another research avenue would be to replicate these findings in specific school subjects. In the present study, self-concept, autonomous motivation, and achievement were assessed in general, irrespective of specific school subjects. In light of research showing that students can differentiate these constructs among school subjects (e.g., Green, Martin, & Marsh, 2007), it would be interesting to verify whether the mediating role of autonomous academic motivation operates equally in math, writing, reading, and so on.

Conclusion

This study examined longitudinal relations between academic self-concept, autonomous academic motivation, and achievement. In line with SDT, our findings suggested that autonomous academic motivation mediates the relation between academic self-concept and academic achievement. These findings have important implications, not only for research on academic self-concept and motivation, but also for interventions designed to increase student achievement in high school. For example, conditions could be established to increase student perception of competence at school, which could promote autonomous motivation (i.e., choice, decision-making, and enjoyment) instead of obligation and pressure, thereby potentially increasing students' achievement levels. Interventions could target school competences by means such as adapting the level of challenge to students' abilities, providing regular competence feedback to students, and showing support and interest in their progress (Deci & Ryan, 2002).

References

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: W.H. Freeman and Company.

Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 51*(6), 1173-1182.

Bentler, P. M. (1995). *EQS structural equations program manual.* Encino, CA: Multivariate Software, Inc.

Browne, M. W., & Cudeck, R. (1993). Alternative ways of assessing model fit. In K. A. Bollen, & J. S. Long (Eds.), *Testing structural equation models* (pp. 136–162). Newbury Park, CA: Sage Publications.

Calsyn, R. J., & Kenny, D. A. (1977). Self-concept of ability and perceived evaluation of others: Cause or effect of academic achievement? *Journal of Educational Psychology, 69*(2), 136-145.

Cole, D. A., & Maxwell, S. E. (2003). Testing meditational models with longitudinal data: Questions and tips in the use of structural equation modeling. *Journal of Abnormal Psychology, 112*(4), 558-577.

Connell, J. P., & Wellborn, J. G. (1991). Competence, autonomy, and relatedness: A motivational analysis of self-system processes. In M. R. Gunnar, & L. A. Sroufe (Eds.), *Self processes and development* (pp. 43-77). Hillsdale, NJ, England: Lawrence Erlbaum Associates, Inc.

Davey, A., Shanahan, M. J., & Schafer, J. L. (2001). Correcting for selective nonresponse in the national longitudinal survey of youth using multiple imputation. *Journal of Human Resources, 36*(3), 500-519.

Deci, E. L., & Ryan, R. M. (1985). The general causality orientations scale: Self-determination in personality. *Journal of Research in Personality (Print), 19*(2), 109-134.

Deci, E. L., & Ryan, R. M. (2002). *Handbook of self-determination research.* Rochester, NY: University of Rochester Press.

Denissen, J. J. A., Zarrett, N. R., & Eccles, J. S. (2007). I like to do it, I'm able, and I know I am: Longitudinal couplings between domain-specific achievement, self-concept, and interest. *Child Development, 78*(2), 430-447.

Fortier, M. S., Vallerand, R. J., & Guay, F. (1995). Academic motivation and school performance: Toward a structural model. *Contemporary Educational Psychology, 20*, 257-274.

Goldberg, M. D., & Cornell, D. G. (1998). The influence of intrinsic motivation and self-concept on academic achievement in second- and third-grade students. *Journal for the Education of the Gifted, 21*(2), 179-205.

Green, J., Martin, A. J., & Marsh, H. W. (2007). Motivation and engagement in English, mathematics and science high school subjects: Towards an understanding of multidimensional domain specificity. *Learning and Individual Differences, 17*(3), 269-279.

Grolnick, W. S., Ryan, R. M., & Deci, E. L. (1991). Inner resources for school achievement: Motivational mediators of children's perceptions of their parents. *Journal of Educational Psychology, 83*(4), 508-517.

Grolnick, W. S., & Slowiaczek, M. L. (1994). Parents' involvement in children's schooling: A multidimensional conceptualization and motivational model. *Child Development, 65*(1), 237-252.

Guay, F., Boggiano, A. K., & Vallerand, R. J. (2001). Autonomy support, intrinsic motivation, and perceived competence: Conceptual and empirical linkages. *Personality and Social Psychology Bulletin, 27*(6), 643-650.

Guay, F., Mageau, G. A., & Vallerand, R. J. (2003). On the hierarchical structure of self-determined motivation: A test of top-down, bottom-up, reciprocal, and horizontal effects. *Personality and Social Psychology Bulletin*, *29*, 992-1004.

Guay, F., Marsh, H. W., & Boivin, M. (2003). Academic self-concept and academic achievement: Developmental perspectives on their causal ordering. *Journal of Educational Psychology, 95*(1), 124-136.

Guay, F., Ratelle, C. F., & Chanal, J. (2008). Optimal learning in optimal contexts: The role of self-determination in education. *Canadian Psychology, 49*, 233-240.

Guay, F., & Vallerand, R. J. (1997). Social context, students' motivation, and academic achievement: Toward a process model. *Social Psychology of Education, 1*, 211-233.

Harter, S. (1999). *The construction of the self: A developmental perspective.* New York: Guilford Press.

Hein, V., & Hagger, M. S. (2007). Global self-esteem, goal achievement orientations, and self-determined behavioural regulations in a physical education setting. *Journal of Sports Sciences*, *25*, 149-159.

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*(1), 1-55.

Jamshidian, M., & Bentler, P. M. (1999). ML estimation of mean and covariance structures with missing data using complete data routines. *Journal of Educational and Behavioral Statistics, 24*(1), 21-24.

Jöreskog, K. G., & Sörbom, D. (1976). Statistical models and methods for test-retest situations. In D. N. M. DeGruijter, & L. J. Van Der Kamp (Eds.), *Advances in psychological and educational measurement* (pp. 135-157). New York: Wiley & Sons.

Jöreskog, K.G., & Sörbom, D. (1993). *LISREL 8: Structural equation modeling with the SIMPLIS command language.* Chicago: Scientific Software International.

Koestner, R., & Losier, G. F. (2002). Distinguishing three ways of being highly motivated: A closer look at introjection, identification, and intrinsic motivation. In E .L. Deci & R .M. Ryan (Eds.), *Handbook of self-determination research* (pp. 101-121). Rochester, NY: University of Rochester Press.

Little, T. D., Preacher, K. J., Selig, J. P., & Card, N. A. (2007). New developments in latent variable panel analyses of longitudinal data. *International Journal of Behavioral Development, 31*(4), 357-365.

Losier, G. F., Vallerand, R. J., & Blais, M. R. (1993). Construction et validation de l'Échelle des Perceptions de Compétence dans les Domaines de Vie (EPCDV). *Science et Comportement*, *23*, 1-16.

Marsh, H. W. (2007). *Self-concept theory, measurement and research into practice: The role of self-concept in educational psychology.* Leicester, UK: British Psychological Society.

Marsh, H. W., Byrne, B. M., & Yeung, A. S. (1999). Causal ordering of academic self-concept and achievement: Reanalysis of a pioneering study and revised recommendations. *Educational Psychologist, 34*(3), 155-167.

Marsh, H. W., & Craven, R. (1997). Academic self-concept: Beyond the dustbowl. In G. Phye (Ed.), *Handbook of classroom assessment: Learning, achievement, and adjustment* (pp. 131-198). Orlando, FL: Academic Press.

Marsh, H. W., & Hau, K. (1996). Assessing goodness of fit: Is parsimony always desirable? *Journal of Experimental Education, 64*(4), 364-390.

Marsh, H. W., Trautwein, U., Lüdtke, O., Köller, O., & Baumert, J. (2005). Academic self-concept, interest, grades, and standardized test scores: Reciprocal effects models of causal ordering. *Child Development, 76*(2), 397-416.

Marsh, H. W., Wen, Z., & Hau, K. (2004). Structural equation models of latent interactions: Evaluation of alternative estimation strategies and indicator construction. *Psychological Methods, 9*(3), 275-300.

Marsh, H. W., & Yeung, A. S. (1998). Top-down, bottom-up, and horizontal models: The direction of causality in multidimensional, hierarchical self-concept models. *Journal of Personality and Social Psychology, 75*(2), 509-527.

Niemiec, C. P., Lynch, M. F., Vansteenkiste, M., Bernstein, J., Deci, E. L., & Ryan, R. M. (2006). The antecedents and consequences of autonomous self-regulation for college: A self-determination theory perspective on socialization. *Journal of Adolescence*, *29*, 761-775.

Peugh, J. L., & Enders, C. K. (2004). Missing data in educational research: A review of reporting practices and suggestions for improvement. *Review of Educational Research, 74*(4), 525-556.

Ratelle, C. F., Guay, F., Vallerand, R. J., Larose, S., & Senécal, C. (2007). Autonomous, controlled, and amotivated types of academic motivation: A person-oriented analysis. *Journal of Educational Psychology, 99*(4), 734-746.

Ratelle, C.F., Guay, F., Larose, S., & Senécal, C. (2004). Family correlates of trajectories of academic motivation during a school transition: A semi-parametric group-based approach. *Journal of Educational Psychology, 96*, 743-754.

Reeve, J. (2002). Self-determination theory applied to educational settings. In E. L. Deci, & R. M. Ryan (Eds.), *Handbook of self-determination research* (pp. 183-203). Rochester, NY: University of Rochester Press.

Schumacker, R. E., & Lomax, R. G. (1996). *A beginner's guide to structural equation modeling*. Hillsdale, NJ, England: Lawrence Erlbaum Associates, Inc.

Shavelson, R. J., Hubner, J., & Stanton, G. C. (1976). Validation of construct interpretation. *Review of Educational Research, 46,* 407-441.

Spinath, B., Spinath, F. M., Harlaar, N., & Plomin, R. (2006). Predicting school achievement from general cognitive ability, self-perceived ability, and intrinsic value. *Intelligence, 34*(4), 363-374.

Stupnisky, R. H., Renaud, R. D., Perry, R. R, Ruthig, J. C., Haynes, T. L., & Clifton, R. A. (2007). Comparing self-esteem and perceived control as predictors of first-year college students' academic achievement. *Social Psychology of Education, 10,* 303-330.

Vallerand, R. J. (1997). Toward a hierarchical model of intrinsic and extrinsic motivation. In M. P. Zanna (Ed.), *Advances in experimental social psychology, vol. 29* (pp. 271-360). San Diego, CA, US: Academic Press.

Vallerand, R. J., Blais, M. R., Briere, N. M., & Pelletier, L. G. (1989). Construction et validation de l'Échelle de Motivation en Éducation (EME) [Construction and validation of the Academic Motivation Scale]. *Canadian Journal of Behavioural Science, 21*, 323–349.

Vallerand, R. J., Fortier, M. S., & Guay, F. (1997). Self-determination and persistence in a real-life setting: Toward a motivational model of high school dropout. *Journal of Personality and Social Psychology, 72*(5), 1161-1176.

Wigfield, A., & Eccles, J. S. (2000). Expectancy-value theory of achievement motivation. *Contemporary Educational Psychology, Special Issue: Motivation and the Educational Process, 25*(1), 68-81.

Wolters, C. A., Yu, S. L., & Pintrich, P. R. (1996). The relation between goal orientation and students' motivational beliefs and self-regulated learning. *Learning and Individual Differences, 8*(3), 211-238.

Table 1
Descriptive Statistics for Model Variables

Variable	N	Mean	SD	Minimum	Maximum
Academic Achievement [a]					
Time 1	925	71.78	8.82	47.00	94.0
Time 2	925	70.76	9.09	9.00	95.00
Autonomous Academic Motivation [b]					
Time 1	925	4.75	5.38	-13.50	17.25
Time 2	925	7.20	4.37	-12.00	18.00
Academic Self-Concept [c]					
Time 1	925	4.89	1.28	1.00	7.00
Time 2	925	5.22	1.02	1.00	7.00

Note: [a] Scores ranged from 0 to 100; [b] scores ranged from -18 to +18; [c] scores ranged from 1 to 7.

Note that means on Time-2 constructs were imputed with the SPSS EM missing values procedure.

Table 2

Confirmatory Factor Analyses and Structural Equation Modeling Analyses: Model Fit Statistics

Model	Description	χ2	df	CFI	TLI	RMSEA	CI RMSEA	Comparison	Δdf	Δχ2
CFA Models										
Model 1	Measurement model	181.15	110	.99	.98	.026	[.029-.041]			
Model 2	Factor loadings invariance	201.41	116	.98	.98	.028	[.022-.035]	M3 vs. M1	6	20.11*
SEM Models										
Model 3	Full Model: Disturbances correlated	201.41	116	.98	.98	.028	[.022-.035]			
Model 4	Full Model: Disturbances not correlated	282.46	119	.97	.96	.039	[.033-.044]	M4 vs. M3	3	99.23*
Model 5	Mediation Model of Autonomous Academic Motivation	205.34	119	.98	.98	.028	[.021-.034]	M5 vs. M3	3	3.85
Model 6	Mediation Model of Academic Self-Concept	215.62	119	.98	.98	.030	[.023-.036]	M6 vs. M3	3	15.54*
Model 7	Additive Model	216.37	120	.98	.98	.029	[.023-.036]	M7 vs. M3	4	15.82*
Model 8	The total effect of academic self-concept on academic achievement	228.25	121	.98	.98	.031	[.025-.037]			

Table 3

Correlations among Model Variables

	1	2	3	4	5	6
1- ACH-T1	__					
2- ACH-T2	.78	__				
3- ACS-T1	.60	.51	__			
4- ACS-T2	.44	.52	.58	__		
5- AUTOM-T1	.35	.39	.60	.40	__	
6- AUTOM -T2	.30	.36	.40	.63	.54	__

Note: ACH = academic achievement; ASC= academic self-concept; AUTOM= autonomous academic motivation; all coefficients were significant at $p < .05$.

Figure Caption

Figure 1. Conceptual models of relations among academic self-concept, autonomous academic motivation, and achievement.

Figure 2. Results of the Full Model.

Figure 3. Results of the Mediation Model of Autonomous Academic Motivation.

Figure 4. Results of the Mediation Model of Academic Self-Concept.

Figure 5. Results of the Additive Model.

1a) Mediation Model of Autonomous Academic Motivation

1b) Mediation Model of Academic Self-Concept

1c) Additive Model