The differentiated mediation effect of academic autonomous and controlled motivation in the relation between self-concept and achievement

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A B S T R A C T

The present study aimed to examine the mediation effect of students' motivation in the relation between students' self-concept and achievement, considering the different regulation types described by Self-Determination Theory. The central objective of our study was to determine if autonomous and controlled motivation types in different school-subjects would mediate differently the relation between self-concepts and achievement. Indeed, autonomous motivation types have been shown to be more related to academic outcomes than controlled ones, and therefore we expected that this would result in differential mediation effects. A 2-wave study was carried out on a sample of 411 high school students in grades 9 and 10. Students' self-concept, self-determined motivations and grades were assessed in 4 different school-subjects (i.e., math, French, English, physical education). Results confirmed our hypothesis and showed that autonomous motivation types mediated the contribution of self-concept to achievement in corresponding school subjects whereas controlled motivation types did not. Educational and methodological implications are discussed and location of introjected approach regulation on the relative autonomy continuum is questioned in regards of previous results confirmed by ours in this study.

1. Introduction

The question of how to promote student achievement and positive academic outcomes is a major concern in educational settings. Many studies have highlighted the importance of academic self-concept in predicting achievement in school (e.g., Wu et al., 2021). Thus, students with a positive self-concept, that is, with positive perceptions of their academic abilities, tend to do better in school. Beyond a positive self-concept, motivation has also been found as a strong predictor of academic achievement (e.g., Hattie et al., 2020). Among motivational theories depicted to investigate this issue, self-determination theory (SDT; Deci & Ryan, 1985; Ryan & Deci, 2017) distinguishes different motivation types, varying in their level of self-determination, from the most autonomous (i.e., intrinsic motivation, identified regulation) to the most controlled (i.e., introjected, external regulations) ones. Results showed that autonomous motivation types (AM types) leads to more positive academic outcomes than controlled motivation types (CM types) (Guay, Ratelle & Chanal, 2008; Deci & Ryan, 2008). In school context, besides the fact that these self-concept and motivation have been found to foster academic achievement, few have investigated how they could act as consorts. In one of the attempt to investigate this issue, Guay,

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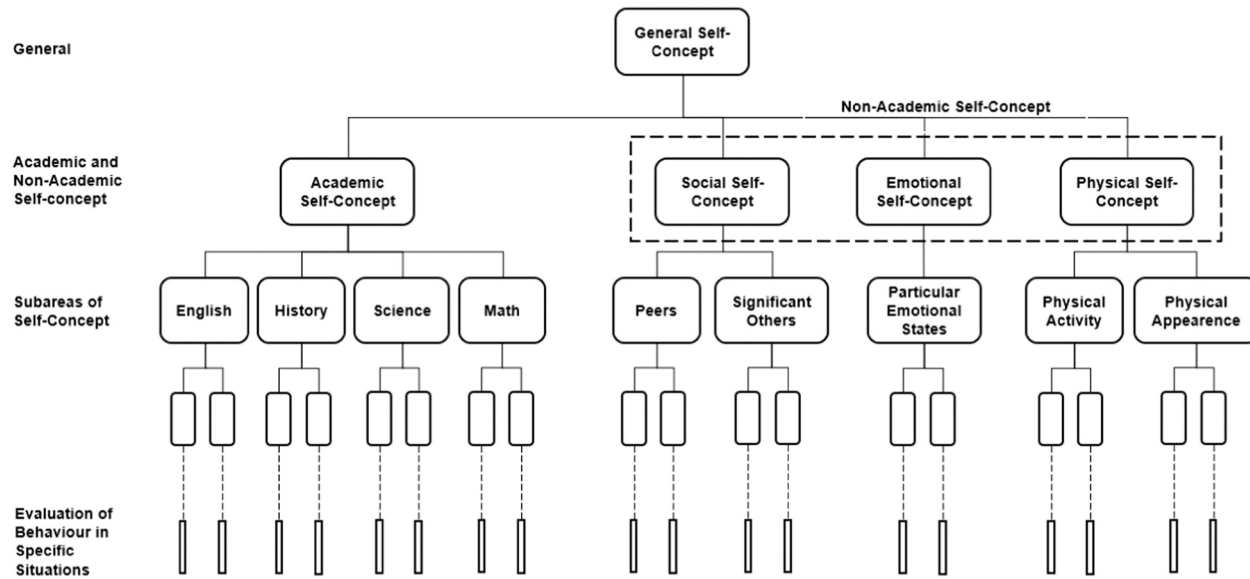*E-mail address:* julien.chanal@unige.ch (J. Chanal).

Fig. 1. The multidimensional and hierarchical model of self-concept from Shavelson, Hubner and Stanton
Adapted to Shavelson et al. (1976).

Ratelle et al. (2010) studied different conceptual models to explain relations between academic self-concept, motivation from an SDT perspective and academic achievement. Their results indicated that the best predictive model among those tested was the one in which self-determined motivation mediated the contribution of self-concept to achievement.

Although conclusive, these results considered self-determined motivation by combining different motivational regulations together into a composite score. Whereas student's self-concept has long been shown to be school subject specific (e.g., Arens et al., 2021; Brunner et al., 2010), only recent investigation about SDT motivation types showed that AM and CM types were not equally specific to school subjects in which they were assessed (Chanal & Guay, 2015; Chanal & Paumier, 2020; Guay & Bureau, 2018). Notably, research on this topic (Chanal & Paumier, 2020) showed that the more autonomous the motivation type was, the more specific to the school subject. Thus, considering these results, one could argue that the mediating process by which motivation mediates the contribution of self-concept to achievement demonstrated in the work of Guay et al. (2010) may only be a result of the effects of AM types and not CM types. More specifically, one may question whether this mediating effect is driven by one type of motivation rather than the other, due to the differences that exist between autonomous and controlled motivation in school subject specificity. In this study, our objective was to examine if the mediating effect of motivation on the relation between self-concept and achievement was different for AM and CM types. Specifically, we wanted to reproduce previous results about the mediational sequence between these three constructs (self-concept -> motivation -> academic achievement) distinguishing the relations for AM and CM motivation types. According to recent development in research on school subject specificity (Chanal & Guay, 2015), we postulated that the motivational sequence found in Guay, Ratelle et al. (2010) will be reproduced, but that the mediating effect of motivation between self-concept and achievement would only be found for AM motivation types and not for CM motivation types.

1.1. Influence of self-concept on achievement

Self-concept can broadly be described as an individual's perceptions of themself, formed through experience and interpretation of their environment (Shavelson et al., 1976). In the academic context, self-concept mainly refers to the students' perceptions of their competences in school or in a school subject. Shavelson et al. (1976) proposed a theoretical model of self-concept in a multidimensional and hierarchical perspective (see Fig. 1). Multidimensional perspective indicate that self-concept consists of multiple distinct domain-specific components and hierarchical perspective implies that self-concept components are positioned at different generality levels (Arens et al., 2021). The Shavelson et al. model considers general self-concept at the apex of the hierarchy. The general self-concept is divided into academic self-concept and non-academic self-concept. Non-academic self-concept is subdivided into social, physical and emotional self-concepts. Academic self-concept differentiated between various school subjects (e.g., math self-concept).

The multidimensionality and hierarchical organization of the self-concept have been supported by various research (e.g., Arens et al., 2021; Brunner et al., 2010). Some research has been particularly interested in the multidimensional and domain-specificity nature of self-concept and studied the correlations among self-concepts in different domains. Support for domain-specificity is established on the high positive correlations between self-concepts in the same domain (e.g., verbal) and the low positive (or negative) correlations between self-concepts in distinct domains (e.g., verbal and math). For instance, Arens et al. (2021) examined correlations between self-concepts in seven school subjects and demonstrated a clear distinction between math-like self-concepts (e.g., math, physics) and verbal-like self-concepts (e.g., English, German). Indeed, math self-concept was highly and negatively correlated with German self-concept ($r = -.47$), and highly and positively correlated with physics self-concept ($r = .40$). Many studies examined the relations between self-concept and academic achievement and showed that self-concept was more strongly related to achievement in corresponding than in non-corresponding school subjects (e.g., Arens et al., 2021; Hansford & Hattie, 1982; Marsh, 1992; Marsh, Trautwein, et al., 2006; Marsh & Craven, 2006; Möller et al., 2009; Trautwein & Möller, 2016).

Although, the association between self-concept and achievement has been clearly established, a crucial question concerns the direction of the relation between these two variables. Three main theoretical models have been postulated: the self-enhancement, the skill development and the reciprocal-effects models (e.g., Marsh et al., 2017; Marsh & Craven, 2006). The self-enhancement model posits that academic self-concept predicts academic achievement but that achievement does not affect self-concept (Calsyn & Kenny, 1977). The skill development model supports the reverse causal relation by proposing that is academic achievement that predicts academic self-concept but that self-concept does not influence achievement (Calsyn & Kenny, 1977). While initially the self-enhancement and skill development models were strongly contrasted, recent studies have shown that a clear-cut position is inappropriate because self-concept and achievement mutually reinforce each other (Arens et al., 2017). Thus, the reciprocal-effects model, which is a more realistic compromise between the self-enhancement and skill-development models, proposes that prior self-concept causes subsequent achievement, and prior achievement causes subsequent self-concept (Marsh & Craven, 2006; Marsh & Martin, 2011). Most empirical studies supported the reciprocal-effects model at the school level (e.g., Pinxten et al., 2010) and in different school subjects (e.g., Arens et al., 2017; Marsh, Trautwein, et al., 2005; Marsh, Chanal, et al., 2006; Marsh et al., 2018).

1.2. Self-determined motivation and its relations with achievement

Contrary to other motivational theories that have treated motivation as a unitary concept (e.g., Bandura, 1997) SDT considers motivation as a *multidimensional* concept. Indeed, SDT recognizes that there are three types of motivation: Intrinsic motivation, extrinsic motivation and amotivation (Ryan & Deci, 2000a). Intrinsic motivation occurs when people do a behavior because the activity itself provides pleasure and satisfaction (Ryan & Deci, 2000a). Three types of intrinsic motivation have been proposed: intrinsic motivation to stimulation (i.e., doing an activity for the sensory pleasure that is felt), intrinsic motivation to know (i.e., doing an activity for the pleasure and satisfaction of learning), and intrinsic motivation toward accomplishment (i.e., doing an activity for the

pleasure of surpassing) (Carbonneau et al., 2012). In contrast to intrinsic motivation, extrinsic motivation involves doing an activity to attain some separate consequences (Ryan & Deci, 2000a). Deci and Ryan (1985) described different regulation types of extrinsic motivation varying in their level of self-determination. Four extrinsic motivations are considered from high to low level of self-determination: integrated, identified, introjected and external regulations. The most self-determined form of extrinsic motivation is integrated regulation. Integrated regulation occurs when people recognize and identify with the value of the activity, and also find that it is congruent with their other interests and values (Ryan & Deci, 2002). This regulation involves that people have form their identity (Deci et al., 1996). A less self-determined form of extrinsic motivation is identified regulation. Identified regulation results from people identifying with the personal importance of a behavior and recognizing it as their own (Deci & Ryan, 2000). Introjected regulation is the third type of extrinsic motivation, in which people engage in a behavior in response to internal pressures, to avoid guilt or anxiety or to attain pride or ego-enhancements (Ryan & Deci, 2000b). Finally, external regulation concerns behaviors that are performed to satisfy an external demand or obtain a reward contingency (Deci & Ryan, 2000). Other than the classical intrinsic/extrinsic one, another distinction occurs in the SDT framework relative to the level of internalization of regulation types. Autonomous motivation refers to behaviors performed voluntarily and by choice, while controlled motivation refers to behaviors constrained by internal and external pressures (Vansteenkiste et al., 2006). Autonomous motivation includes intrinsic, integrated and identified regulations, whereas controlled motivation comprises introjected and external regulations (Vansteenkiste et al., 2006). Finally, the third type of motivation is amotivation and refers to a lack of intentionality or a lack of motivation (Deci & Ryan, 2008).

Many studies investigated the relation between academic motivation and achievement. Some research has considered the motivation types proposed by SDT separately (i.e., using the subscales as separate variables) some others used the Relative Autonomy Index (i.e., RAI, a composite score based on measurements of these regulation types and obtained by weighting the scores obtained) and some others considered AM and CM scores (e.g., by calculating the mean obtained for either intrinsic, integrated and identified or introjected and external regulations). All studies using the RAI demonstrated that the higher students' autonomous motivation, the higher their achievement in school in general (Fortier et al., 1995; Grolnick et al., 1991; Guay & Vallerand, 1997; Kusurkar et al., 2013; Ratelle et al., 2005). In research considering AM and CM separately, results confirmed the positive effect of AM on academic achievement (Brunet et al., 2015; Kusurkar et al., 2013; Litalien et al., 2015), or school subjects performance (Botnaru et al., 2021; De Naeghel et al., 2012; Jeno et al., 2018). On the other hand, results demonstrated negative or non-significant relation between CM and academic achievement (Brunet et al., 2015; Kusurkar et al., 2013; Litalien et al., 2015), or grades in various school subjects (Botnaru et al., 2021; De Naeghel et al., 2012; Jeno et al., 2018). In research considering each motivation type proposed by SDT separately, results confirmed that intrinsic motivation and identified regulation were positively associated with academic achievement (Howard et al., 2021; Litalien et al., 2015; Orsini et al., 2019; Taylor et al., 2014, study 1), or grades in math (Leroy & Bressoux, 2016; Lohbeck, 2018). Concerning controlled motivation types, results are less consistent. Indeed, while Taylor et al. (2014, study 1) demonstrated that introjected and external regulations were negatively related to achievement, Orsini et al. (2019) and Howard et al. (2021) showed no significant relation for these two regulations. Other studies indicated that grades in math were negatively related to external regulation, but did not significantly associate with introjected regulation (Leroy & Bressoux, 2016; Lohbeck, 2018). Finally, in some studies, no significant relation was found between all regulation types and achievement in school (Cokley et al., 2001; Fairchild et al., 2005) and in the language learning context (McEown et al., 2014; Noels et al., 1999).

1.3. Mediation of self-concept effect on achievement by motivation

Whereas many studies have investigated the relation between motivation and achievement or between self-concept and achievement, few have examined the relation between these three variables taken together. More specifically, the question arises of a potential mediating role of motivation in the relation between self-concept and achievement. Marsh et al. (1999) proposed in the self-enhancement model that student characteristics such as conscientious effort, persistence, intrinsic motivation, academic choice, and coursework selection would be mediating variables in the relation between self-concept and achievement. The postulated mediating role of motivation is also consistent with SDT (Deci & Ryan, 1985; Ryan & Deci, 2017) which postulates that perceived competence (a concept closely related to self-concept) leads to more positive consequences (i.e., such as higher achievement) thought academic motivation. In the same way, within the SDT framework, the hierarchical model of intrinsic and extrinsic motivation (HMIEM; Vallerand, 1997) proposes a causal sequence linking perceptions of competence to motivations, and motivations to different outcomes.

Guay, Ratelle et al. (2010) tested different conceptual models to explain relations between academic self-concept, self-determined motivation and academic achievement: a mediational model of motivation, a mediational model of self-concept and an additive model in which both motivation and self-concept predicted achievement. Their results indicated that the model that best fit the data was the model in which motivation mediated the contribution of self-concept to achievement. Two studies provided support for these mediation results by focusing exclusively on intrinsic motivation. Khalaila (2015), conducted a study with a sample of nursing students, demonstrating that intrinsic motivation mediated the relationship between academic self-concept and achievement. Similarly, Locher et al. (2021) showed that intrinsic motivation in reading mediated the association between reading self-concept and reading comprehension, as assessed by standardized reading tests. Furthermore, Lohbeck et al. (2021) investigated the relationship between two types of motivation (intrinsic and extrinsic motivations), physical self-concept and physical performance. Their results revealed that intrinsic motivation played a mediating role in the association between physical self-concept and physical performance, while extrinsic motivation did not mediate this relationship.

These studies support the motivational mediation model and also suggest differences in results based on different types of motivational regulations. However, the number of studies is limited, making it difficult to draw definitive conclusions. Specifically, only

intrinsic and extrinsic motivations were used as mediational variables. Therefore, it is challenging to determine if the mediational effect is driven by all types of motivational regulations or only specific types. Additionally, studies supporting the motivational mediation model have focused on self-concept, motivation, and achievement at a single hierarchical level, either related to the overall school or a specific school subject. However, we believe that a more accurate analysis of motivational processes in an academic context should consider multiple school subjects simultaneously. Previous studies that have examined various school subjects simultaneously have demonstrated differentiated relationships between self-concept and achievement (Chen et al., 2013; Marsh & Yeung, 1997) as well as between motivation types and achievement (Chanal & Guay, 2015; Chanal & Paumier, 2020; Guay & Bureau, 2018) based on the specific school subject. Therefore, it is necessary to investigate whether the mediating effect of different types of motivational regulations will vary according to different school subjects.

1.4. The present study

In the present study, we aimed to evaluate the mediating role of different types of motivation described by SDT (i.e., autonomous or controlled) between self-concept and achievement in multiple school subjects. Our objective was to test whether both AM and CM types were involved in mediating the relationship between self-concept and academic achievement. We aimed to extend the motivational mediation model by considering the different types of motivation described by SDT and by simultaneously examining multiple school subjects. Specifically, we wanted to investigate whether the motivational mediation model existed only for AM types and not for CM types. Recent studies have shown that AM types are more subject-specific than CM types (Chanal & Guay, 2015; Paumier & Chanal, 2020). Therefore, based on these results, we expected that the mediating effect of motivation between self-concept and grades would be more strongly supported by AM types than by CM types.

Our hypotheses were as follows:

Hypothesis 1. : As the first step of the mediation test, we hypothesized that self-concepts in specific school subjects will predict achievement in corresponding school subjects.

Hypothesis 2. As the second step of the mediation test, we expected that self-concepts in specific school subjects will predict motivation in corresponding school subjects. More specifically, we postulated that self-concepts will predict AM but not (or less) CM types in corresponding school subjects.

Hypothesis 3. As the final step of the mediation test, we postulated that motivation will mediate relation between self-concepts and achievements in corresponding school subjects. More specifically, in accordance with the school-subject-specificity hypothesis, we postulated that the mediation effects will be supported for AM but not for CM types.

2. Method

2.1. Participants and Procedure

Participants were students (228 girls and 183 boys) attending two junior high school in the Canton of Geneva, Switzerland. Students were in Grade 9 and 10 at time 1 (M_{age} = 13.705; SD_{age} = 0.731) and in Grade 10 and 11 at time 2 (M_{age} = 14.245; SD_{age} = 0.713). Students completed questionnaires at the end of the school year (T1: from May to June) and in the following year at mid-year (T2: from November to February).

Written consent was required for students and their parents to participate in the study. The ethics commission of the faculty of psychology of the University of Geneva approved this study. The data was obtained and analyzed anonymously.

2.2. Measures

2.2.1. Students' self-concept

Six items of the Self-Description Questionnaire (Guérin et al., 2003) were used to assess /students' self-concept. The scale was adapted to measure self-concept at the contextual level (i.e., self-concept in school) and at the situational level (i.e., self-concepts in math, French, English, and physical education). For each of six items (e.g., "I am doing well in …"), students were asked to rate how much they agreed with each item on a 7-point Likert scale from 1 (*strongly disagree*) to 7 (*strongly agree*). The same six items were used to assess each self-concept at the contextual and situational levels. The scale was administered at time 1. Cronbach's alphas for this measure were.94 for school,.97 for math,.94 for French,.96 for English,.96 for physical education.

2.2.2. Academic motivation

Student's motivation was measured using a scale developed by Chanal et al. (2019). The scale was adapted to assess student's regulation types at the contextual level (i.e., motivation toward school in general) and at the situational level (i.e., motivation toward four school subjects: math, French, English, physical education). We assessed seven subscales measuring seven regulation types of self-determined motivation. The subscales are as follows: intrinsic motivation to experience stimulation (e.g., "Because I am having fun in…"; αs between.81 and.94), intrinsic motivation for achievement (i.e., a combination of intrinsic motivation to know and intrinsic motivation toward accomplishments) (e.g., "Because I discover new things in…"; αs between.81 and.88), identified regulation (e.g., "Because I consider … to be important for me"; αs between.77 and.87), introjected approach regulation (e.g., "To be proud of myself";
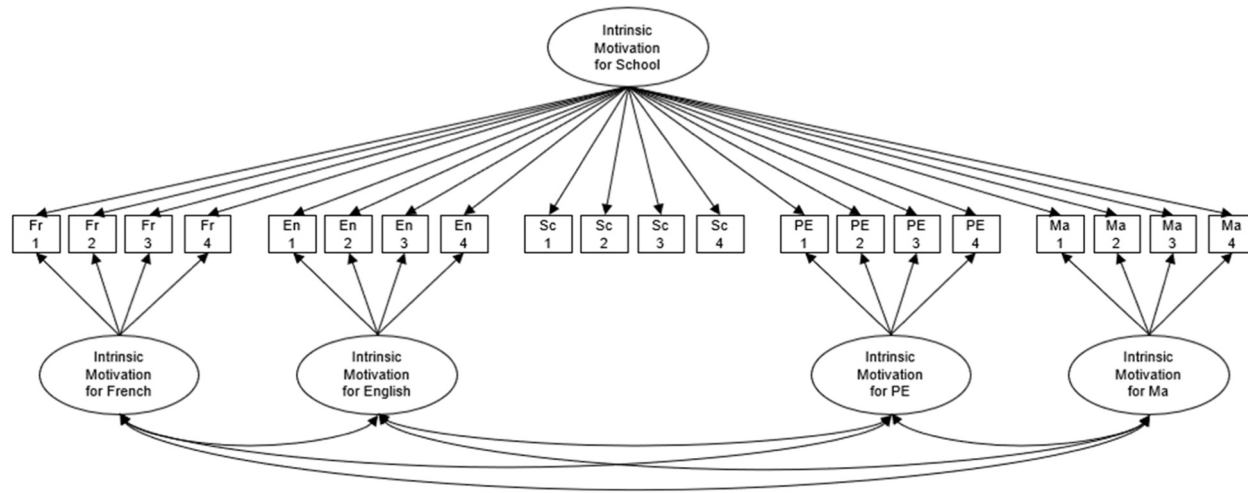
Fig. 2. CTCM-1 Model for Intrinsic Motivation. Note. Fr 1 - Fr 4 = items for French, En 1- En 4 = items for English, PE 1 – PE 4 = items for physical education, Ma 1 – Ma 4 = items for math, Sc 1 – Sc 4 = items for school.

αs between.72 and.81), introjected avoidance regulation (e.g., "Because I don't want to be rejected; αs between.62 and.73), external approach regulation (e.g., " To get good grades"; αs between.64 and.69) and external avoidance regulation (e.g., "To avoid bad grades"; αs between.66 and.75). The same four items were used to assess each regulation at the contextual and situational levels. The students were asked how much they agreed with each reason "to participate in school" or "to participate in a particular school subject" on a 7-point Likert scale from 1 (*never*) to 7 (*all the time*). The scale was administered to students at time 1 and 2.

2.2.3. Academic achievement

The schools provided us with students' grades at the end of the two years in each of the four academic subjects (i.e., math, French, English, and physical education).

2.3. Statistical analyses

2.3.1. Self-concept and motivation types scores

In order to properly test our mediational models, we extracted self-concepts and motivation types latent constructs factor scores using correlated trait-correlated method minus one (CTCM-1) models (Eid et al., 2003). CTCM-1 model appeared to be the most suitable model to account for the multidimensional and hierarchical organization of self-concept and motivation (Brunner et al., 2010; Chanal & Guay, 2015). Indeed, CTCM-1 model allows distinguishing the variance attributable to the contextual level (i.e., toward school) and to the situational level (i.e., school subjects). More precisely, self-concept and motivation at the contextual level is considered as a single trait, whereas self-concept and motivation in different school subjects are considered as correlated methods or school subjects' deviations from this global trait (see Fig. 2 for intrinsic motivation). Thus, the specific latent factors for each subject represent deviations from the global factor by capturing the common but specific variance in subject items that is above the common variance at the contextual level.

We then realized CTCM-1 models for each of the 7 motivation types (i.e., intrinsic motivation to experience stimulation, intrinsic motivation for achievement, identified regulation, introjected approach regulation, introjected avoidance regulation, external approach regulation, and external avoidance regulation) at time 1 and at time 2 and for students' self-concept at time 1.

We performed a full information maximum likelihood (FIML) estimation using *Mplus* version 7 (Muthén & Muthén, 2012). All models were tested with maximum likelihood estimation using robust standard errors (MLR estimation). Less than 1% of the data were missing. To evaluate the model fit, we used the chi-square values, the comparative fit index (CFI), the Tucker-Lewis index (TLI), the root mean square error of approximation (RMSEA), and the standardized root mean square residual (SRMR). CFI and TLI values closed to or above.90 and.95 are deemed acceptable and excellent fit to the data respectively (Hu & Bentler, 1999; Marsh, Hau, et al., 2005). For RMSEA, values closed to or below.08 are indicative of an adequate fit (Hu & Bentler, 1999; Marsh, Hau, et al., 2005). A value of.08 (or lower) for the SRMR is considered indicative of a good model fit (Hu & Bentler, 1999).

Table 1 presents fit indices for each regulation type CTCM-1 models at T1 and T2, and self-concept CTCM-1 models at T1. All models show an excellent fit to the data. As expected by the school-subject-hypothesis, AM types were more specific than CM types because the quantity of shared variance at the situational level was higher for AM types than for CM types (see Table 2). At T1, on average, the percentages of variance shared at the situational level for intrinsic motivation-stimulation (59% of total variance), for

Table 1
Fit Indices of the CTCM-1 Models.

Model	χ^2	df	RMSEA	CFI	TLI	SRMR	AIC	BIC
Intrinsic motivation-stimulation								
Time 1	132.084	108	.023	.995	.991	.026	26611.675	27101.943
Time 2	152.634	108	.032	.990	.98	.029	26670.47	27160.739
Intrinsic motivation-achievement								
Time 1	311.532	108	.068	.942	.898	.041	27916.14	28406.408
Time 2	400.863	108	.081	.920	.860	.052	27571.467	28061.735
Identified								
Time 1	176.518	108	.039	.981	.967	.046	26935.888	27426.157
Time 2	179.226	108	.040	.978	.962	.058	27103.999	27594.268
Introjected Approach								
Time 1	179.318	108	.040	.981	.967	.036	28651.053	29141.322
Time 2	165.230	108	.036	.986	.975	.030	28016.247	28506.516
Introjected Avoidance								
Time 1	181.258	108	.041	.977	.96	.051	28491.07	28981.338
Time 2	170.923	108	.038	.981	.966	.042	28180.318	28670.586
External Approach								
Time 1	311.521	199	.037	.976	.963	.047	34177.8	34784.607
Time 2	144.482	108	.029	.99	.983	.033	27891.811	28382.08
External Avoidance								
Time 1	143.853	108	.028	.989	.981	.031	28372.285	28862.554
Time 2	155.544	108	.033	.985	.974	.031	28170.856	28661.125
Self-Concept								
Time 1	485.97	315	.037	.982	.975	.030	30761.896	31479.909

intrinsic motivation-achievement (40%), and for identified regulation (42%) were higher than for introjected approach (22%), introjected avoidance (17%), external approach (10%), and external avoidance regulations (15%). The results found at T2 were similar, on average, the percentages of variance shared at the situational level for intrinsic motivation-stimulation (57% of total variance), for intrinsic motivation-achievement (37%), and for identified regulation (41%) were higher than for introjected approach (21%), introjected avoidance (16%), external approach (6% in total variance), and external avoidance regulations (15% in total variance).

3. Results

3.1. Relations between self-concepts and grades

To evaluate whether self-concept predicts achievement (Hypothesis 1), two regression models were realized for each school subject. In the first regression model, self-concept at time 1 was considered as independent variable and achievement at time 2 as dependent variable (see Figure model A1). In the second regression model, the same regression model was also tested by controlling for achievement at time 1 (see Fig. 3, model A2). These two regression models were tested for each school subject separately. Results are presented in Table 3. When T1 grades were not controlled, T1 self-concepts predicted significantly positively T2 grades in all school subjects (i.e., 4/4). That is, higher self-concept in a school subject was related to higher grade in corresponding school subject. These results are in line with the self-enhancement model and with our first hypothesis. When controlling for T1 grades, T1 self-concepts

Table 2
Variance due to Specific and Contextual Levels for Each School Subject and on Average.

| Intrinsic motivation-stimulation	Specific T1/T2	Contextual T1/T2	Residual T1/T2
Mathematics	.58/.57	.20/.19	.23/.24
French	.43/.48	.30/.27	.27/.25
English	.61/.50	.12/.19	.27/.31
Physical education	.75/.74	.04/.06	.22/.20
Average	.59/.57	.16/.18	.25/.25
Intrinsic motivation-achievement	Specific T1/T2	Contextual T1/T2	Residual T1/T2
Mathematics	.31/.27	.29/.35	.40/.37
French	.29/.28	.35/.32	.36/.39
English	.45/.38	.20/.20	.35/.41
Physical education	.56/.53	.07/.12	.37/.35
Average	.40/.37	.23/.25	.37/.38
Identified	Specific T1/T2	Contextual T1/T2	Residual T1/T2
Mathematics	.38/.34	.23/.24	.38/.42
French	.32/.36	.31/.27	.37/.37
English	.42/.36	.15/.17	.43/.46
Physical education	.55/.57	.07/.06	.38/.37
Average	.42/.41	.19/.19	.39/.41
Introjected Approach	Specific T1/T2	Contextual T1/T2	Residual T1/T2
Mathematics	.16/.12	.37/.39	.47/.49
French	.17/.15	.36/.39	.47/.47
English	.22/.20	.31/.35	.48/.45
Physical education	.34/.28	.18/.16	.48/.46
Average	.22/.21	.30/.32	.47/.47
Introjected Avoidance	Specific T1/T2	Contextual T1/T2	Residual T1/T2
Mathematics	.15/.11	.23/.32	.62/.57
French	.12/.12	.26/.29	.61/.59
English	.13/.12	.21/.29	.66/.59
Physical education	.27/.28	.15/.19	.59/.53
Average	.17/.16	.21/.27	.62/.57
External Approach	Specific T1/T2	Contextual T1/T2	Residual T1/T2
Mathematics	.09/.01	.25/.31	.66/.67
French	.09/.06	.25/.27	.66/.67
English	.08/.04	.25/.26	.67/.70
Physical education	.16/.11	.24/.24	.60/.64
Average	.10/.06	.24/.27	.65/.67
External Avoidance	Specific T1/T2	Contextual T1/T2	Residual T1/T2
Mathematics	.13/.16	.31/.28	.56/.56
French	.11/.12	.35/.31	.54/.57
English	.13/.18	.30/.25	.57/.57
Physical education	.22/.15	.20/.27	.58/.58
Average	.15/.15	.29/.28	.56/.57
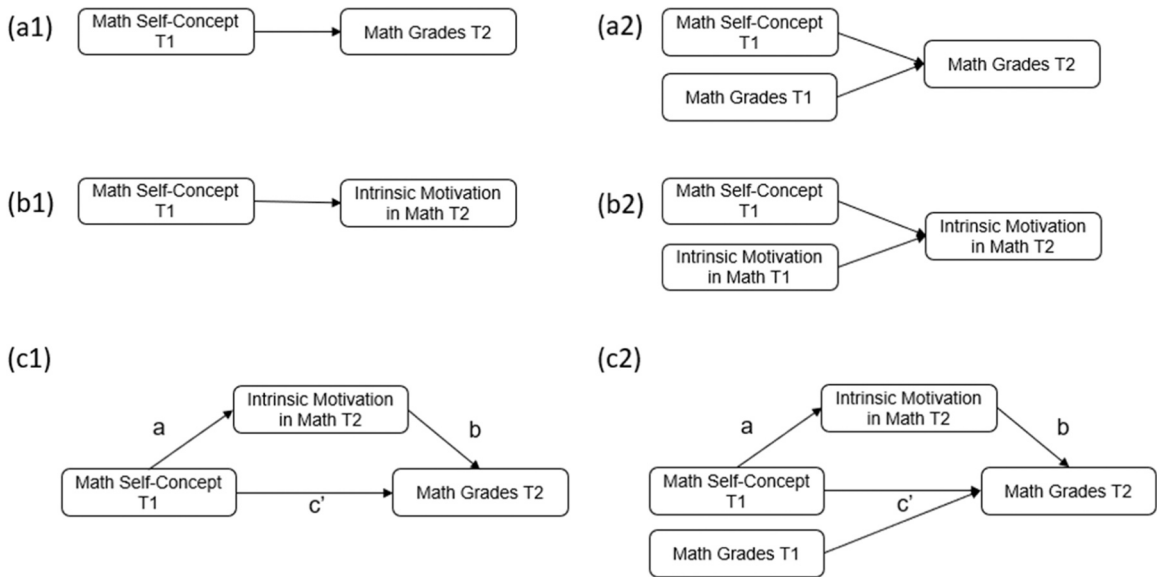
Fig. 3. Models tested for math self-concept, math grades and intrinsic motivation in math.

Table 3
Regressions of Self-concept on Grade.

Variable	Without T1 grades controlled						With T1 grades controlled					
	β	SE β	t	df	p	R^2	β	SE β	t	df	p	R^2
Self-concept												
Math	.33	.05	6.97	392	< .001	.11	.01	.04	0.18	388	.855	.45
French	.20	.05	3.95	392	< .001	.04	-.02	.04	-0.54	388	.587	.46
English	.28	.05	5.76	392	< .001	.08	.00	.04	-0.01	388	.992	.45
Physical education	.38	.05	8.14	388	< .001	.15	.16	.05	3.31	382	.001	.30
Average	.30						.04					
Number of relations on 4 school subjects					4/4						1/4	

Note. We examined the impact of T1 self-concept on T2 grade in corresponding school subjects.

predicted T2 grades in only 1 school subject among the 4 (i.e., 1/4). These results showed that later grades are more predicted by previous grades than by previous self-concepts in our study.

3.2. Relations between self-concepts and regulation types

To evaluate whether self-concept predicts motivation types (Hypothesis 2), two regression models were realized for each motivation type and for each school subject. In the first regression model, self-concept at time 1 was considered as independent variable and motivation type at time 2 as dependent variable (see Fig. 3, model b1). In the second regression model, we also tested this regression model by controlling for motivation type at time 1 (see Fig. 3, model b2).

Results are provided in Table 4 for AM types and in Table 5 for CM types. Self-concepts significantly predicted 21 times motivation in corresponding school subjects on the 28 models tested (7 motivation types for 4 school subjects). When controlling for T1 motivation, self-concepts significantly predicted 16 times motivation in corresponding school subjects on the 28 models tested.

We hypothesized that these results would be different regarding the specificity of the motivation types involved. As expected, self-concepts predicted significantly AM types in corresponding school subjects at each time (i.e., 12/12 times). In contrast, self-concepts only predicted CM types in corresponding school subjects approximately half of the time (i.e., 9/16). Specifically, self-concepts predicted introjected approach in all school subjects (i.e., 4/4), introjected avoidance in 2 school subjects (i.e., 2/4), external approach in 3 school subjects (i.e., 3/4), whereas self-concept did not predict external avoidance in any school subject (i.e., 0/4). When controlling for T1 motivation types, self-concepts were still more related to AM types (i.e., 9/12) than to CM types (i.e., 7/16). Specifically, self-concepts predicted intrinsic motivation-stimulation in all school subjects (i.e., 4/4), intrinsic motivation-achievement in 3 school subjects (i.e., 3/4), and identified regulation in 2 school subjects (i.e., 2/4). For CM types, self-concepts were related to introjected approach in 3 school subjects (i.e., 3/4), to introjected avoidance in 1 school subject (i.e., 1/4), to external approach in 3 school subjects (i.e., 3/4), and to external avoidance in none of the school subjects (i.e., 0/4).

Table 4
Regressions of Self-Concept on Autonomous Motivation Types.

Variable	Intrinsic Stimulation											
	Without T1 motivation types controlled						With T1 motivation types controlled					
	β	SE β	t	df	p	R²	β	SE β	t	df	p	R²
Self-concept												
Math	.47	.04	10.68	397	< .001	.22	.24	.05	4.59	396	< .001	.31
French	.32	.05	6.71	397	< .001	.10	.18	.05	3.40	396	.001	.17
English	.33	.05	6.93	397	< .001	.11	.15	.05	2.96	396	.003	.22
Physical education	.52	.04	12.09	397	< .001	.27	.14	.05	2.68	396	.008	.43
Average	.41						.18					
Number of relations on 4 school subjects				4/4							4/4	
	Intrinsic Achievement											
	Without T1 motivation types controlled						With T1 motivation types controlled					
Self-concept												
Math	.35	.05	7.41	397	< .001	.12	.25	.05	5.00	396	< .001	.18
French	.21	.05	4.33	397	< .001	.05	.14	.05	2.69	396	.007	.09
English	.20	.05	3.96	397	< .001	.04	.08	.05	1.63	396	.104	.15
Physical education	.37	.05	8.03	397	< .001	.14	.17	.05	3.49	396	.001	.29
Average	.28						.16					
Number of relations on 4 school subjects				4/4							3/4	
	Identified											
	Without T1 motivation types controlled						With T1 motivation types controlled					
Self-concept												
Math	.32	.05	6.69	397	< .001	.10	.19	.05	3.90	396	< .001	.22
French	.16	.05	3.17	397	< .001	.02	.07	.05	1.48	396	.139	.10
English	.19	.05	3.94	397	< .001	.04	.08	.05	1.73	396	.085	.20
Physical education	.38	.05	8.10	397	< .001	.14	.10	.04	2.21	396	.028	.39
Average	.26						.05					
Number of relations on 4 school subjects				4/4							2/4	

Note. We examined the impact of T1 self-concept on T2 autonomous motivation types in corresponding school subjects.

3.3. Mediation analyses

For Hypothesis 3, we realized mediational analyses, in which motivation was considered as mediating the relations between self-concepts and achievement. In these mediation models, self-concepts at time 1 were considered as independent variables, grades at time 2 were considered as dependent variables, and motivation types at time 2 as mediator variables (see model c1 in Fig. 3). As for Hypothesis 1 and Hypothesis 2, we tested mediational model without controlling for achievement at time 1 in the first time, then we added it in a second time (see model C2 in Fig. 3). Mediational models were tested for each motivation type and for each school subject resulting in 28 models.

More specifically, we tested the significance of the indirect effect using the bootstrapping method as recommended by Zhao et al. (2010). Bootstrapping method is a nonparametric resampling procedure with replacement, which allows to obtain an empirical sampling distribution of the indirect effect *a x b* (Hayes, 2009) (see model c1 in Fig. 3). This sampling distribution is used to construct confidence intervals for the indirect effect. In this study, we used the 95% bias-corrected bootstrap confidence intervals with 10000 bootstrap samples to test the significance of the indirect effect. If zero is not between the lower and upper bound, we can claim that the indirect effect is not zero with 95% confidence (Hayes, 2009). In this case, it is inferred that the indirect effect is significant, and therefore there is a mediation effect. For these mediation analyses, the "model indirect" option implemented in *Mplus* was applied.

Results of mediation analyses are presented in Table 6. On the 28 mediation analyses (i.e., 7 regulation types and 4 school subjects), indirect effects were significant 9 times using the 95% bias-corrected bootstrap confidence intervals when T1 grade was not controlled (i.e., 9/28 times), and indirect effects were significant approximately half of the time when T1 grade was controlled (i.e., 12/28 times). More importantly, in accordance with our hypothesis, results showed that the mediation model of motivation was more established for AM that for CM types. Indeed, for AM types, the indirect effects were significant and positive 5 times on the 12 models tested when T1 grade was not controlled (i.e., 5/12 times) and 8 times on the 12 models tested when T1 grade was controlled (i.e., 8/12 times). More specifically, the indirect effects were significant when T1 grade was not controlled for intrinsic motivation-stimulation in 2 school subjects (i.e., 2/4), intrinsic motivation-achievement in 1 school subject (i.e., 1/4) and identified regulation in 2 school subjects (i.e., 2/4). When T1 was controlled, the indirect effects were significant for intrinsic motivation-stimulation in all school subjects (i.e., 4/4), intrinsic motivation-achievement in 2 school subjects (i.e., 2/4), and identified regulation in 2 school subjects (i.e., 2/4). That is, for these regulation types, higher self-concepts were predictive of stronger AM types, which were in turn predictive of higher grades.

In contrast, for CM types, the indirect effects were significant and positive 4 times on the 16 models tested when T1 grade was or was not controlled (i.e., 4/16 times without T1 grade controlled and 4/16 times with T1 grade controlled). The mediation model of motivation was supported only for introjected approach in all school subjects (i.e., 4/4 without T1 grade controlled and 4/4 with grade controlled). In contrast, the motivational mediation model was not supported in all school subjects for introjected avoidance (i.e., 0/4 without T1 grade controlled and 0/4 with grade controlled), external approach (i.e., 0/4 without T1 grade controlled and 0/4 with

Table 5

Regression of Self-Concept on Controlled Motivation Types.

Variable	Introjected Approach											
	Without T1 motivation types controlled						With T1 motivation types controlled					
	β	SE β	t	df	p	R^2	β	SE β	t	df	p	R^2
Self-concept												
Math	.12	.05	2.37	397	.018	.01	.07	.05	1.49	396	.136	.05
French	.16	.05	3.22	397	.001	.03	.11	.05	2.17	396	.030	.07
English	.19	.05	3.94	397	< .001	.04	.13	.05	2.58	396	.010	.07
Physical education	.32	.05	6.73	397	< .001	.10	.16	.05	3.35	396	.001	.26
Average	.20						.12					
Number of relations on 4 school subjects				4/4							3/4	
	Introjected Avoidance											
	Without T1 motivation types controlled						With T1 motivation types controlled					
Self-concept												
Math	.06	.05	1.24	397	.217	.00	.04	.05	0.91	396	.362	.08
French	.05	.05	0.98	397	.328	.00	.04	.05	0.74	396	.457	.02
English	.11	.05	2.28	397	.023	.01	.09	.05	1.86	396	.064	.06
Physical education	.24	.05	4.84	397	< .001	.06	.17	.05	3.59	396	< .001	.13
Average	.12						.09					
Number of relations on 4 school subjects				2/4							1/4	
	External Approach											
	Without T1 motivation types controlled						With T1 motivation types controlled					
Self-concept												
Math	.24	.05	5.02	397	< .001	.06	0.24	0.05	4.81	396	< .001	.06
French	.12	.05	2.32	397	.021	.01	0.11	0.05	2.27	396	.024	.01
English	-.01	.05	-0.13	397	.895	.00	-0.02	0.05	-0.34	396	.737	.01
Physical education	.26	.05	5.40	397	< .001	.07	0.19	0.05	4.00	396	< .001	.13
Average	.15						0.13					
Number of relations on 4 school subjects				3/4							3/4	
	External Approach											
	Without T1 motivation types controlled						With T1 motivation types controlled					
Self-concept												
Math	-.05	.05	-.93	397	.354	.00	-.05	.05	-0.99	396	.324	.05
French	.00	.05	.06	397	.951	.00	-.01	.05	-0.15	396	.882	.06
English	.02	.05	.33	397	.744	.00	.03	.05	0.57	396	.567	.02
Physical education	.03	.05	.59	397	.554	.00	.03	.05	0.54	396	.592	.04
Average	.00						.00					
Number of relations on 4 school subjects				0/4							0/4	

Note. We examined the impact of T1 self-concept on T2 controlled motivation types in corresponding school subjects.

grade controlled), and external avoidance regulations (i.e., 0/4 without T1 grade controlled and 0/4 with grade controlled). That is, for CM types, whereas introjected avoidance and external approach and avoidance regulations did not significantly mediate the relation between self-concept and grades, higher self-concepts were predictive of stronger introjected approach regulations, which were in turn predictive of higher grades.

4. Discussion

The purpose of this study was to test the mediating role of motivation in the relation between self-concept and achievement considering the different regulation types described by SDT. More precisely, we investigated the differential effects of AM and CM types on their relation between self-concept and achievement in different school-subjects in secondary school students.

We expected that AM types would mediate the relation between self-concept and achievement in corresponding school subjects more than controlled ones. Our results confirmed our hypothesis by showing that AM types played a mediating role more than CM types did. Indeed, AM types mediated the relation between self-concepts and grades in corresponding school subjects 5 times on the 12 models tested when prior grades were not controlled and 8 times on the 12 models tested when prior grades were controlled. Note the fact that there were more significant indirect effects when prior grades were controlled, indicating that the mediating role of AM types was more important concerning achievement change across the period. In contrast, only introjected approach regulation mediated the relation between self-concept and grades while other controlled motivation types did not play this mediating role, whether prior grades were controlled or not.

Our findings firstly confirmed that motivational factors are key variables explaining the relation between self-concept and achievement in the self-enhancement model as postulated by Marsh et al. (1999). They are consistent with previous studies which demonstrated the mediating role of motivation in the relations between self-concept and achievement (Guay et al., 2010; Khalaila, 2015; Locher et al., 2021; Lohbeck et al., 2021). However, as postulated, our results demonstrated differentiated mediation effects depending on the level of self-determination of motivation types. These differentiated effects are in line with result of previous studies that showed that intrinsic but not extrinsic motivation played a mediating role between self-concept and performance (Lohbeck et al.,

Table 6

Indirect Effects of Motivational Mediation Models.

	Without T1 grades controlled			With T1 grades controlled		
	Estimate	95% CI	R^2 grade	Estimate	95% CI	R^2 grade
Intrinsic Motivation-Stimulation						
Mathematics	.023	[− .005,.065]	.116	**.040**	**[.019,.064]**	.476
Physical Education	**.027**	**[.011,.045]**	.165	**.027**	**[.012,.044]**	.317
French	.003	[− .017,.030]	.038	**.019**	**[.005,.037]**	.478
English	**.037**	**[.018,.064]**	.110	**.046**	**[.028,.071]**	.509
Intrinsic Motivation-Achievement						
Mathematics	**.027**	**[.009,.051]**	.126	**.026**	**[.011,.044]**	.467
Physical Education	.008	[− .004,.020]	.150	.007	[− .003,.018]	.302
French	.001	[− .013,.013]	.038	.005	[− .004,.017]	.467
English	.010	[− .001,.029]	.085	**.015**	**[.005,.032]**	.469
Identified						
Mathematics	.011	[− .005,.032]	.113	.008	[− .004,.023]	.451
Physical Education	**.013**	**[.003,.026]**	.157	**.016**	**[.007,.028]**	.317
French	.006	[− .001,.020]	.042	.004	[− .003,.014]	.465
English	**.023**	**[.009,.046]**	.114	**.021**	**[.008,.039]**	.477
Introjected Approach						
Mathematics	**.010**	**[.002,.024]**	.131	**.008**	**[.001,.018]**	.461
Physical Education	**.010**	**[.002,.020]**	.156	**.010**	**[.002,.019]**	.308
French	**.008**	**[.001,.023]**	.045	**.007**	**[.001,.020]**	.468
English	**.010**	**[.00028]**	.086	**.013**	**[.004,.029]**	.467
Introjected Avoidance						
Mathematics	.004	[− .001,.015]	.121	.004	[− .001,.014]	.460
Physical Education	.004	[− .002,.012]	.149	.004	[− .001,.012]	.302
French	.002	[− .002,.012]	.041	.001	[− .001,.008]	.464
English	.001	[− .005,.010]	.078	.000	[-. 007,.005]	.450
External Approach						
Mathematics	.012	[− .001,.030]	.117	.008	[− .001,.022]	.451
Physical Education	.004	[− .003,.012]	.148	.002	[− .004,.009]	.300
French	.001	[− .005,.009]	.038	.000	[− .005,.007]	.464
English	.000	[− .009,.007]	.087	.000	[− .007,.004]	.451
External Avoidance						
Mathematics	.000	[− .005,.002]	.449	.000	[− .005,.003]	.449
Physical Education	.000	[− .004,.001]	.302	.000	[− .004,.001]	.302
French	.000	[− .004,.003]	.467	.000	[− .004,.004]	.467
English	-.001	[− .011,.003]	.451	-.001	[− .008,.002]	.451

Note. We examined the mediating role of motivation types on the relation between self-concept and grade in corresponding school subjects. CI = confidence interval. Significant indirect effects are shown in **bold**.

2021). Results of the present study therefore extended previous findings clearly demonstrating that the mediation effect of motivation between self-concept and achievement was more supported for AM and CM types.

A potential explanation for these results could beside in the motivation types difference in specificity in situational motivation. Indeed, Chanal and Guay (2015) have developed the school-subject-specificity hypothesis which states that AM types are more specific to the situational level in which they were assessed than CM types. According to their hypothesis, results of our study showed that AM types were more specific than the CM types. In fact, our results indicated that the percentage of variance of the items shared at the situational level decreased as motivation type become less autonomous except for external approach. On average, the percentages of variance shared at the situational level for intrinsic motivation-stimulation (59% and 57% at T1 and T2, respectively), for intrinsic motivation-achievement (40% and 37%), and for identified regulation (42% and 41%) were higher than for introjected approach (22% and 21%), introjected avoidance (17% and 16%), external approach (10% and 6%), and external avoidance regulations (15% at each time). Interestingly, we can note that we found significant mediation effects for the motivation type that were found to be the most specific to the school subjects.

In our study, we distinguished between two types of introjected regulation: introjected approach (approaching self-worth or pride) and introjected avoidance (avoiding loss of self-worth, shame or guilt) regulations like in Assor et al. (2009). In this study, they demonstrated that introjected approach and avoidance regulations were differently associated with specific outcomes. Our results are in line with these, as we also demonstrate a different pattern of mediation effects for introjected approach and avoidance regulations. Indeed, introjected approach regulation indirectly and positively influenced the relations between self-concepts and achievement, whereas this was not the case for introjected avoidance regulation. This finding demonstrates that future research in education might consider both types of introjected regulation because they could be associated differently with outcomes. Similarly, Sheldon et al. (2017) demonstrated, using a multidimensional scaling, that positive introjected regulation (that corresponds to introjected approach regulation) was located on the same side of relative autonomy continuum as identified regulation and intrinsic motivation, and that negative introjected regulation (that corresponds to introjected avoidance regulation) was located on the same side as external regulation and amotivation. These results, by demonstrating that introjected approach was located on the positive side of the relative autonomy continuum, indicated that this regulation is more closely associated with autonomous motivation than controlled

motivation. We must note that, if we had considered introjected approach regulation as an autonomous motivation type in our study, our results would have fully supported our hypotheses. Specifically, only regulations considered as autonomous (i.e., including introjected approach) would have mediated the relationship between self-concepts and grades in corresponding school subjects regardless of whether prior grades were controlled or not (i.e. 9/16 or 12/16 models). Conversely, controlled motivation types (i.e., excluding introjected approach) would have not played this mediating role, regardless of whether grades were controlled or not (i.e., 0/12).

Finally, our findings provide some important implications for teaching practices. Indeed, the results of the present study highlighted the key role of self-concept and autonomous motivation for achievement in a specific school subject. These results indicate that enhancing students' self-concept and autonomous motivation in a school subject may lead to higher achievement in that school subject. To increase their students' achievement, teachers should focus on teaching practices aimed at enhancing students' self-concept and autonomous motivation. Some intervention programs were designed to improve self-concept especially through praise, performance feedback and attributional retraining (see Craven et al., 1991, for an overview). Moreover, O'Mara et al. (2006), in their meta-analyses, showed the self-concept interventions were significantly effective and found that feedback and praise had the strongest effect size for such interventions. Furthermore, several SDT-based intervention programs have been developed for increasing students' autonomous motivation emphasizing autonomy-supportive practices (see Guay et al., 2016; Reeve & Cheon, 2021, for reviews). Reeve and Cheon (2021), in their review from 51 autonomy-supportive teaching interventions, showed although that these interventions produced students benefits such as increase in autonomous motivation types, which in turn led to more engagement in school, better grades and more positive emotions.

5. Limitations and future directions

One limitation of this study is that it only examined the relationship between self-concept, motivation, and achievement in corresponding school subjects, without considering the links between different non-corresponding school subjects. According to Marsh's internal/external frame of reference model (1986), there are relationships between achievement and self-concepts in different school subjects. Specifically, academic achievement in a subject has a positive effect on self-concept in that corresponding subject (e.g., verbal achievement on verbal self-concept), but has a negative effect on self-concept in a non-corresponding subject (e.g., verbal achievement on math self-concept). Based on these widely replicated and demonstrated findings (Möller et al., 2020), it can be speculated that the motivational relationships considered in each school subject may also be influenced by the existing motivational mechanisms in other school subjects. Therefore, it would be useful in future research on motivational mediation to consider the between-school subject relationships and not just the within-school subject relationships.

6. Conclusion

The present study examined the mediating role of academic motivation in the relation between self-concept and achievement considering the different regulation types described by Self-Determination Theory and various school subjects. Our results suggested that the effect of students' self-concept on achievement is mediated by autonomous and less by controlled motivation types. These findings have implications for teaching practices by showing that enhancing students' self-concept and autonomous motivation in a school subject may lead to higher achievement in that school subject.

CRediT authorship contribution statement

DP: Conceptualization, Methodology, Writing – original draft, Writing - review & editing, JC: Conceptualization, Methodology, Writing – original draft, Writing - review & editing.

Declaration of Competing Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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