Journal of Youth and Adolescence (2019) 48:326–340
https://doi.org/10.1007/s10964-018-0952-0

EMPIRICAL RESEARCH

Student Self-Efficacy, Classroom Engagement, and Academic Achievement: Comparing Three Theoretical Frameworks

E. Olivier[1] · I. Archambault[2] · M. De Clercq[1] · B. Galand[1]

Received: 24 July 2018 / Accepted: 19 October 2018 / Published online: 12 November 2018

Abstract

Student self-efficacy, behavioral engagement, and emotional engagement are key factors for academic achievement. Research has yet to identify the developmental cascades linking these four constructs. Three theoretical frameworks, i.e., Self-Efficacy Theory, the Self-System Model of Motivational Development, and Expectancy-Value Theory, suggest different nexus. Following 671 students (51.8% girls) from their 4th to 6th grade, this study aims to assess competing hypotheses from these three frameworks in math. Three cross-lag models were tested to test each theoretical framework. A fourth and final model was tested to include the significant paths from the previous models. Mediation paths were also tested. Results mainly support assumptions from Self-Efficacy Theory, that is student self-efficacy and academic achievement are mutually associated from 4th to 6th grades. Some of the propositions of Expectancy-Value Theory were also supported. Self-efficacy was associated with later emotional engagement and academic achievement. However, emotional engagement in 5th grade was negatively associated with achievement in 6th grade and was not associated with behavioral engagement. Assumptions from the Self-System Model were not supported by the data. Testing the fourth model revealed an unexpected developmental cascade: 5th-grade self-efficacy mediated the association between 4th-grade achievement and 6th-grade emotional engagement. This last finding may have great implications for young adolescents as emotional engagement is an indicator of student well-being and intrinsic value of learning. Implications for theory validation and intervention targets for adolescents are discussed.

Keywords Student engagement · Self-efficacy · Academic achievement · Self-Efficacy Theory · Self-System Model of Motivational Development · Expectancy-Value Theory

Introduction

Early experiences of success have far-reaching consequences for student positive development in educational and social domains (Lewis et al. 2011; Shogren et al. 2017). Starting from elementary school, student achievement is closely tied to underlying motivation. Student self-efficacy and active engagement in school are among the most influential motivational factors leading to achievement (Fredricks et al. 2004). In this line, different theoretical frameworks, such as Self-Efficacy Theory, the Self-System Model of Motivational Development, and Expectancy-Value Theory, argue toward a complex set of interrelations between self-efficacy, classroom engagement, and academic achievement. Yet, the nexus between these constructs varies from one theoretical perspective to another. Which one of these theories best represents student early experience in school? This question is not yet answered because empirical studies rarely contrast these theories. As a result, properly understanding the multi-faceted and developmental interplay between self-efficacy, classroom engagement, and academic achievement requires further investigations particularly among elementary school students. This study thus aims at assessing the possible developmental pathways between these critical factors in math, a subject matter on which students spend a significant portion of their classroom learning time (Lemieux et al. 2017). In doing so, this study will contrast and test competing hypotheses relying on three of the most recognized theories in the field of achievement motivation, Self-Efficacy Theory, the Self-System Model, and Expectancy-Value Theory.

✉ E. Olivier
elizabeth.abby.olivier@gmail.com

[1] Université catholique de Louvain, Louvain-la-Neuve, Belgium

[2] Université de Montréal, Montréal, Canada

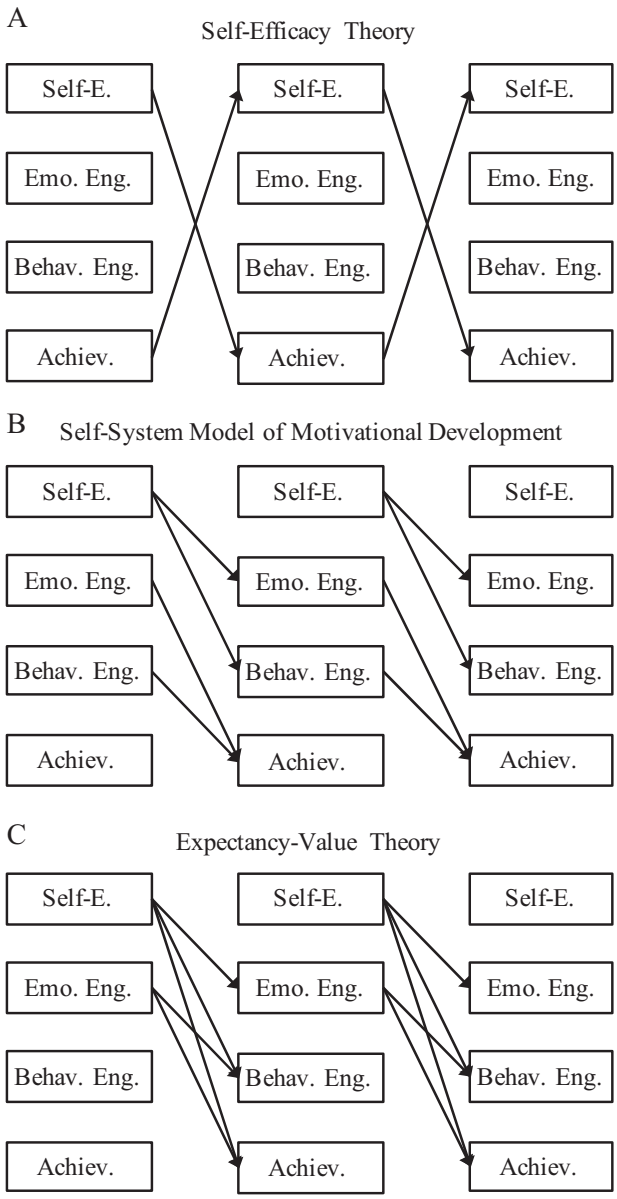

Fig. 1 Hypothetical links for each theoretical framework

Self-Efficacy

Theorists often focus on self-efficacy or related constructs to explain student achievement and performance in school. Yet, definitions of this construct vary from one theory to another. According to Bandura (1997) and proponents of the Self-Efficacy Theory, student self-efficacy is a situation-specific belief that students have on their ability to organize and execute the actions required to learn and master tasks and assignments at a satisfactory level (Schunk and Mullen 2012). Moreover, Self-Determination Theory, in which the Self-System Model is anchored, uses the term *perceived competence*. The Self-System Model defines the self-perception of competence as a basic psychological need to experience oneself as able to attain valued outcomes and master challenging tasks (Deci and Ryan 2000). This conceptualization includes the knowledge of how to attain a desired outcome (perceived strategy) and the belief of being able to execute this strategy (Connell 1990). Although close to the perspective put forward by Bandura, this definition implies that the person has to wish to do a task to have the need to feel competent at it. Finally, Expectancy-Value Theory refers to *ability beliefs* (Eccles et al. 1983; Wigfield and Eccles 2000). In line with Self-Efficacy Theory and Self-Determination Theory, this construct is the evaluation that students make of their current competence according to their own perceptions in a broad domain. In Expectancy-Value Theory, ability beliefs are also student perceptions of competence specifically compared to peers (Wigfield and Eccles 2000). Student ability beliefs then influence *expectancy for success*, that is how students think they will perform on a specific task in the future (Eccles et al. 1983). According to Expectancy-Value Theory, ability beliefs and expectancy for success are distinct in two ways. Ability beliefs relate to a broad domain and to current competence, whereas expectancy for success relates to specific tasks and concern future outcomes.

Although they bear important similarities, these four constructs—self-efficacy, perceived competence, ability beliefs, and expectancy for success—do not constitute a single factor (Rodgers et al. 2014). They often refer to different scopes. For example, (Bandura 1997) argued that self-efficacy is task-specific, whereas, according to Wigfield and Eccles (2000), ability belief refers to the broader domain-related self-evaluation of competence (math, Language Arts). Moreover, the Self-System Model generally refers to a broader representation of perceived competence (Connell and Wellborn 1991). In a recent review and assessment of these task- and domain-related self-evaluations, Marsh et al. (2018) claim that "a critical unresolved issue is how well domain-specific measure of […] self-efficacy predicts future performance in longitudinal studies" (p. 4). Therefore, the current study will focus on the common component of these constructs, that is, student domain-specific perception of their ability to perform with satisfactory results. As this definition is close to the one proposed by Bandura (1997), this study will refer to this common conceptual component as *self-efficacy*.

Linking Student Self-Efficacy and Achievement from Different Theoretical Perspectives

Self-Efficacy Theory

Over the years, several theories and frameworks have posited various processes to explain student success or failure in school. Anchored in the Social cognitive perspective

proposed by Bandura in the 1960s, the widely accepted Self-Efficacy Theory is among the first model to suggest developmental pathways between self-efficacy and achievement (see Bandura (1997) for a detailed presentation of this theory). More specifically, the theory (see Fig. 1, Panel A) posits that student self-efficacy is an important direct predictor of success in academic assignments and evaluations (Schunk and Mullen 2012); academic achievement being an evaluation of performance and learning in school. According to the theory, academic achievement is thus closely tied to the feeling that students have of their individual competencies and their perceptions of how good they are in each domain, especially in the core subjects such as math. Because not all tasks are mastered at the same pace and with the same success, such individual perceptions and how it relates to actual achievement is subject-specific (Schunk and Mullen 2012). The model also stresses that experiences of success and mastery in a task, in turn, support the development of self-efficacy. The information that students gather about their actual performance is thus among the most important sources of self-efficacy (Schunk and Pajares 2009). As a result, students who are satisfied with their academic achievement are more likely to feel efficacious in school. Self-efficacy also explains that prior achievement leads to future achievement and success (Zimmerman 2000). Overall, relying on these theory-driven assumption Self-Efficacy Theory postulates a bidirectional influence between self-efficacy and achievement. Adopting a more empirically-driven approach, Marsh and Craven (2005) proposed the Reciprocal Effect Model that bears important similarities with Self-Efficacy Theory. Relying on over 20 years of investigation Marsh and collaborators (e.g. Arens et al. 2017; Pekrun et al. 2017) postulate that self-concept and achievement are closely linked to each other over time and especially in the math domain. Self-concept is broader than self-efficacy as it includes self-confidence, self-worth, self-acceptance, competence, and ability (Marsh and Craven 2005), whereas self-efficacy is more constricted to self-confidence. Self-confidence is thus the common feature of these two concepts. Therefore, there is substantial evidence that Self-Efficacy Theory should be representative of student actual academic development.

The Self-System Model of motivational development

A few decades later, in the 1980s, two theoretical frameworks, the Self-System Model and Expectancy-Value Theory, were developed in parallel. Both proposed to include indicators of student engagement as part of the process linking self-efficacy to achievement. In the school context, engagement is defined as a manifestation of student motivation, through their active investment in learning and academic activities (Connell and Wellborn 1991). Student engagement is a multidimensional construct (Fredricks et al. 2004). Behavioral and emotional engagement are often studied together, as theories of student engagement all agree that these two dimensions are key factors in student school functioning (for review, see Eccles and Wang (2012)). Behavioral engagement refers to student observable actions in class, e.g., participation, effort, attention, following instructions, while emotional engagement refers to affective reactions to the classroom context and to assignments, e.g., enthusiasm, appreciation, interest, and enjoyment (Finn 1989; Fredricks et al. 2004). These two dimensions of engagement are also domain-specific. For instance, students who are emotionally or behaviorally engaged in reading and writing tasks are not necessarily engaged in math tasks (Trautwein et al. 2009; Wigfield et al. 2009).

With the addition of indicators of student behavioral and emotional engagement, the Self-System Model and Expectancy-Value Theory went a step further in explaining student academic achievement. Yet, these two models put forward quite different developmental cascades to explain student success or failure in school. For instance, similarly to the Self-Efficacy Theory, the Self-System Model (see Fig. 1, Panel B) assumes that student self-efficacy leads to academic achievement, but postulates that this process operates through engagement (mediation) (see Connell (1990) and Connell and Wellborn (1991) for a detailed presentation of this theory). Drawing on Self-Determination Theory (Deci and Ryan 2000), this model postulate that there are three motivational needs than, when fulfilled, permit students to fully engage in classroom tasks, e.g., by participation, attention, and interest (Connell and Wellborn 1991). These motivational needs are senses of autonomy, relatedness, and competence. As stated previously, sense of competence is of particular interest for this study as it is comparable to self-efficacy, which allows contrasting the developmental cascade proposed by the Self-System Model to other theoretical frameworks. Also, the satisfaction of the three motivational needs is supposed to have a unique contribution to student academic development. The Self-System Model thus proposes that student sense of competence lead to a positive behavioral and emotional engagement in the classroom and, in turn, to an optimal academic achievement.

Expectancy-Value Theory

This theory (see Fig. 1, Panel C) support a more complex set of interrelations between self-efficacy, achievement, and engagement (see Eccles et al. (1983) and Wigfield and Eccles (2000) for a detailed presentation of this theory). It postulates that prior self-efficacy leads to later emotional engagement, behavioral engagement, and achievement. It also assumes that emotional engagement relates to later

behavioral engagement and achievement. There are thus several assumptions in this model that are here presented one by one. First, Expectancy-Value Theory assumes that student self-efficacy, that is how they perceive their current abilities, relates to later expectations for success (not part of this study) and task value. Among other components, task value taps into student interest and positive emotions in class, otherwise known as intrinsic value (Wigfield and Eccles 2000). Intrinsic value overlaps with emotional engagement, which also includes interest and enjoyment (Fredricks et al. 2004). Therefore, according to Expectancy-Value, self-efficacy should lead to emotional engagement. Second, self-efficacy and emotional engagement both lead to behavioral engagement, which includes effort, attention, compliance, etc. Such behaviors are examples of achievement-related choices showing student desire to learn and master classroom assignments. Expectancy-value Theory thus postulates that student behavioral investment is the result of an inner motivation to learn, which is represented by self-efficacy and emotional engagement (or task value). Finally, these two components—self-efficacy and emotional engagement—also lead to student achievement. As such, if students value learning, are interested, enthusiasm, and feel competent in class, it is most likely reflected in their actual achievement (Eccles et al. 1983). The last postulate to mention from this theory is the assumption that student prior achievement enhances later self-efficacy (Eccles and Wigfield 2002). However, this process is specific to student individual interpretation of their achievement (Wigfield and Eccles 2000). Hence, an evaluation by a teacher or a standardized test should not directly influence student self-efficacy as this process has to operate through student personal interpretation of their performance. These interpretations are sensitive to other inner mechanisms such as causal attributions and achievement goals (Eccles et al. 1983), which are beyond the scope of this study. Globally, Expectancy-Value Theory shares similar characteristics to Self-Efficacy Theory and the Self-System Model, which makes it exhaustive, but less parsimonious.

Do Empirical Studies Support These Theoretical Assumptions?

Many empirical studies, whether theoretically based or not, have investigated the nexus between student self-efficacy, achievement, and engagement. All relying on student domain-specific perception of self-efficacy, studies show that students who feel competent and able to attain academic demands have an optimal achievement (Leondari and Gialamas 2002). Mastering math tasks seems to depend strongly on a belief in personal abilities to do so (Freiberger et al. 2012). In turn, past experiences of success are determinants of such self-confidence, as argued in Self-Efficacy Theory (Weidinger et al. 2017). Regardless of the use of general- or domain-specific evaluations of student self-efficacy, some even argue that this influence between self-efficacy and achievement is bidirectional (Guay et al. 2003; Marsh et al. 2016) and grows stronger over time, as students gain information about their performances and the amount of effort required to master a task (Weidinger et al. 2017). A recent study by Arens et al. (2017) confirmed that student self-efficacy and achievement contribute to each other over time.

When introducing student engagement in the nexus between self-efficacy and achievement, studies find mixed results. For example, Marsh et al. (2016) concluded that, while achievement contributed to later effort, prior effort did not explain later achievement. Similarly, other studies found that prior academic performance may enhance student behavioral and emotional investment in the classroom (Dotterer and Lowe 2011; Ladd and Dinella 2009). Furthermore, and in contrast with results from the Marsh et al. (2016) study, other researchers found that the links between engagement and achievement are bidirectional (Hughes et al. 2008; Pekrun et al. 2017). It also seems that student self-efficacy may trigger behavioral engagement (Chouinard et al. 2007). Here again, student perceptions of being efficacious and how it relates to the amount of effort put into learning is highly domain-specific (Trautwein et al. 2009). Student self-efficacy also support their interest in math (Marsh et al. 2005). Beyond this, positive emotions in class are likely to have a pivotal role in student scholastic experience: interest, enthusiasm, and appreciation of math learning seems to fuel student perception of self-efficacy (Li et al. 2010), as well as their participation and effort, and attention (Li and Lerner 2013).

Although many studies have examined the relations between self-efficacy and achievement, and some have also considered student behavioral or emotional engagement, very few have investigated the potential process (mediation) assumed in the aforementioned theories, especially the Self-System Model. A study conducted by Trautwein et al. (2009) among adolescents shows that student math self-efficacy support achievement through enhanced effort in this domain. Green et al. (2012) also found a similar pattern, showing that behavioral and emotional engagement explained the association between general academic ability and student achievement. However, these studies used only two time-points and did not include a test of the assumed mediation effect. Finally, two studies have investigated the links between self-efficacy, achievement, and indicators of engagement using cross-lag models with more than two time-points. Marsh et al. (2016), among a sample of secondary students, investigated the nexus between self-efficacy, achievement, and effort. These authors showed that self-efficacy and achievement were mutually related, each

fueling the other. They also found that student achievement and self-efficacy lead to later classroom effort, but that effort did not contribute to achievement and self-efficacy. Among elementary students, Viljaranta et al. (2014) have identified that performance leads to self-efficacy and, in turn, to interest for math, suggesting that self-efficacy is a process linking achievement to emotional engagement. This developmental cascade is neither supported by the Self-System Model nor by Expectancy-Value Theory. These two studies share a common strength that is the use of cross-lag models, thus allowing to assess bidirectional and mediation links between student self-efficacy, engagement, and achievement in several directions. In contrast, using linear models, in which a predictor is associated with an outcome through a mediator, forces a specific direction, hence increasing the probability of confirming the hypothesis without assessing other possible pathways.

Current Study

This study seeks to untangle the links and developmental cascades between four motivational constructs: self-efficacy, student behavioral and emotional engagement, and academic achievement. Following students from 4th through 6th grades, the main objective of this study is to identify whether one of the theoretical frameworks (Self-Efficacy Theory, Self-System Model of Motivational Development, or Expectancy-Value Theory) is representative of the real-world setting. The second and alternative objective was exploratory. If none of the theoretical frameworks is entirely supported by the data, this study further aims at identifying a model fitting the data. Evidence suggests that the motivational process leading to achievement is domain-specific (Trautwein et al. 2009). Therefore, investigations are conducted in the math domain in which competing hypotheses from the three alternative frameworks are tested (Fig. 1). Given the vast literature supporting bidirectional influences between self-efficacy and achievement, the hypothesis guiding this study is that results would mainly support Self-Efficacy Theory.

Methods

Sample

The Engagement Project was conducted in seven elementary schools from one school board in the province of Quebec (Canada). It originally comprised 1621 students and 102 teachers who were followed from 2009 to 2012. The vast majority of the sample was Caucasian and belonged to middle-class families, which is representative of students in this school board and of the population of Quebec outside of Montreal (MELS 2016). Students who participated in this larger study were between 1st and 6th grade. Student- and teacher-reported data was collected for students between 3rd and 6th grades ($n = 1249$). With younger students, in 1st and 2nd grades, only teacher-reported data was collected. These students were thus not included in the current study. In Quebec, elementary school comprises grades one to six. Teachers are responsible to teach all main subjects to students (i.e., math, Language Arts, science, etc.)

The present study relied on an accelerated longitudinal design to have data for students on three consecutive school years (4th, 5th, and 6th grade). Students in 4th, 5th, and 6th grades were selected because these years are the three last of elementary school before students transition to secondary school. Following recommendations by Little (2013), students retained in the sample participated in at least two years of the study. The study design for accelerated longitudinal design is displayed in Table 1. Cohorts in bold are those who were included in this study. Three cohorts were thus included in this sample: One cohort of 4th graders followed across three (2009–12) consecutive years (cohort 4; no missing data by design) and two cohorts of 4th (cohort 3; missing data for 6th grade by design) and 5th grade students (cohort 5; missing data for 4th grade by design) followed across two years (respectively 2010–11 and 2011–12). The final sample included 671 students (51.8% girls). Fifty teachers were also part of this sample (85% female). Twenty-two percent of teachers had between 0 and 10 years of teaching experience, 32% had between 11 and 25 years of experience, and 46% had more than 25 years of experience.

Missing data not due to the accelerated longitudinal design was mostly due to students being absent on the day of data collection or teachers not returning their questionnaire. Analyses of missing data patterns confirmed this trend. For Cohort 1, missing data ranged between 11.11 and 20.00% for student-reported measures and from 10.67 and 28.89% for teacher-reported measures. For Cohort 2, missing data ranged between 9.69 and 13.94% for student-reported measures and from 10.58 and 15.87% for teacher-reported measures. For Cohort 3, missing data ranged

Table 1 Organization of data for the longitudinal accelerated design

	Year 1 2009–2010	Year 2 2010–2011	Year 3 2011–2012
Cohort 1 ($n = 208$)			3rd grade
Cohort 2 ($n = 182$)		3rd grade	4th grade
Cohort 3 ($n = 205$)	3rd grade	**4th grade**	**5th grade**
Cohort 4 ($n = 225$)	**4th grade**	**5th grade**	**6th grade**
Cohort 5 ($n = 241$)	**5th grade**	**6th grade**	
Cohort 6 ($n = 188$)	6th grade		

Note. Lines in bold represent the cohorts and time points included in this study

Table 2 Correlations and descriptive statistics

		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
1.	Gender													
2.	Self-efficacy (4^{th})	-0.27^{***}												
3.	Self-efficacy (5^{th})	-0.34^{***}	0.68^{***}											
4.	Self-efficacy (6^{th})	-0.22^{***}	0.67^{***}	0.76^{***}										
5.	Behav. Eng. (4^{th})	0.17^{***}	0.26^{***}	0.24^{***}	0.16^{***}									
6.	Behav. Eng. (5^{th})	0.10^{*}	0.19^{***}	0.34^{***}	0.30^{***}	0.50^{***}								
7.	Behav. Eng. (6^{th})	0.13^{***}	0.08^{t}	0.20^{***}	0.32^{***}	0.50^{***}	0.55^{***}							
8.	Emoti. Eng. (4^{th})	-0.12^{**}	0.59^{***}	0.48^{***}	0.43^{***}	0.49^{***}	0.30^{***}	0.25^{***}						
9.	Emoti. Eng. (5^{th})	-0.10^{**}	0.49^{***}	0.66^{***}	0.54^{***}	0.29^{***}	0.48^{***}	0.34^{***}	0.65^{***}					
10.	Emoti. Eng. (6^{th})	−0.05	0.45^{***}	0.54^{***}	0.62^{***}	0.13^{***}	0.39^{***}	0.49^{***}	0.50^{***}	0.71^{***}				
11.	Achiev. (4^{th})	-0.16^{***}	0.57^{***}	0.44^{***}	0.45^{***}	0.27^{***}	0.17^{***}	0.05	0.32^{***}	0.21^{***}	0.21^{***}			
12.	Achiev. (5^{th})	−0.06	0.55^{***}	0.54^{***}	0.45^{***}	0.28^{***}	0.27^{***}	0.10^{*}	0.33^{***}	0.31^{***}	0.28^{***}	0.68^{***}		
13.	Achiev. (6^{th})	−0.04	0.55^{***}	0.54^{***}	0.55^{***}	0.21^{***}	0.20^{***}	0.14^{***}	0.34^{***}	0.26^{***}	0.31^{***}	0.69^{***}	0.76^{***}	
Mean in Maths.			3.82	3.79	3.75	4.44	4.37	4.41	3.97	3.85	3.80	3.29	3.13	3.16
SD in Maths.			0.83	0.91	0.82	0.60	0.60	0.48	0.94	0.98	0.92	0.70	0.92	0.87
Internal consistency			0.76	0.83	0.87	0.80	0.80	0.80	0.87	0.87	0.89	0.74	0.81	0.85
Min-max			1–5	1–5	1–5	1–5	1–5	1–5	1–5	1–5	1–5	1–5	1–5	1–5

between 12.45 and 13.69% for student-reported measures and from 14.11 and 17.01% for teacher-reported measures. Missing data were handled with the Mplus7 Maximum Likelihood estimator.

Procedure

Prior to data collection, the research team obtained active parental consent for all students in the sample to participate in the study. Students and teachers also gave their active consent to participate. Participation rates were above 90%. At the end of the research project, all participating schools received a portrait of student motivation, engagement, and achievement. The research team discussed a few solutions to promote engagement with school principals and teachers. This was the main incentive to participate in this study. Parents and students did not receive direct incentives to participate. Twice a year (November and April), students had one hour to answer a computerized questionnaire on their experience in school. Each classroom was supervised by two trained research assistants. If necessary or asked by students, assistants read the questions out loud. During this time, teachers answered a paper-pen questionnaire on the behaviors and school performances of their students.

Measures

Self-efficacy

Students reported their self-efficacy in math using a scale drawn from the New Approaches New Solutions project (Janosz et al. 2010). Students rated items such as "I think I do well in math assignments" on a scale ranging from 1 ("almost never") to 5 ("almost always"). At each data collection (November and April), students answered two items to assess their self-efficacy. For each year, a mean score was computed (combining November and April scales), thus including four items. Table 2 shows internal consistency metrics.

Student engagement

Students reported their level of behavioral and emotional engagement in math using the Dimensions of School Engagement Scale (Archambault and Vandenbossche-Makombo 2014). The behavioral engagement subscale has three items, such as "I listen to the teacher's explanations during math activities". The emotional engagement subscale has three items, such as "What we learn in math class is interesting". As for the self-efficacy scale, mean scores were computed for each school year (November and April). Students rated the items on a scale ranging from 1 ("almost never") to 5 ("always")—see Table 2 for internal consistency metrics.

Academic achievement

Student achievement in math was teacher-reported. Teachers rated the achievement of each student compared to the other students in the class, from 1 ("significantly below average") to 5 ("significantly above average"). As teachers in elementary school are responsible for assessing student

performance, this measure is a reliable evaluation of academic achievement (Duncan et al. 2007; Pagani et al. 2001). For each year, a mean score of student achievement in math was computed—see Table 2 for internal consistency metrics.

Gender

Students reported their gender (0 = male; 1 = female). Gender was included as a covariate. Studies indicate that the level of self-efficacy, engagement, and achievement vary between boys and girls, but that the links between these constructs are equivalent between genders (Baroody et al. 2016; Chouinard et al. 2007).

Analytic Strategy

First, descriptive statistics and correlations were conducted. The alternative models were then tested using path analysis models in Mplus7. The first model included only autoregressive paths, gender as a covariate, and concomitant residual correlations between constructs to assess stability coefficients between the four constructs: self-efficacy, behavioral and emotional engagement, and achievement between 4^{th}, 5^{th}, and 6^{th} grades. The three hypothetical models were then assessed from the most to the less parsimonious: 1) Self-Efficacy Theory, 2) the Self-System Model, and 3) Expectancy-Value Theory. The links included in each model are depicted in Fig. 1. In all path models, residual correlations between variables at each time point were included. If none of the three models were entirely supported, a final model was tested including the most likely paths identified in previous models, as done by (Li and Lerner 2013). Also, if indicated by the theory, mediation effects were tested using bootstrapped standard errors with $n = 1000$ drawn (Preacher and Hayes 2008). Finally, as students are nested within classrooms, an ideal assessment of the hypotheses should have accounted for the nested-structure of data. However, this was not possible due to some limitations of the software. These limitations and alternatives are discussed in the limitation section.

This study relied on the five statistical indicators suggested by Little (2013) to assess the fit of each model. The Chi-square compares the estimated model to the tested model. Its value should be lower than three times the degrees of freedom and should not be significantly different. The Comparative Fit Index (CFI) and the Tucker-Lewis Index (TLI) compare the fit of the tested model to that of the null model. These indicators suggest a great fit if the value is above .99, a good fit if the value is between .95 and .99, and an acceptable fit if the value is between .90 and .95. The Root Mean Square Error Approximation (RMSEA) and the Standardized Root Mean Square Residual (SRMR) compare the tested model to the saturated model. They indicate a great fit when their value is below .01, a good fit when the value ranges from .02 to .05, and an acceptable fit when the value ranges from .05 to .08. The adjustment of the tested model was also compared with a Chi-square difference test. This allowed identifying if a model fitted the data better, thus being a better representation of student actual developmental cascades.

Results

Preliminary Analyses

Table 2 presents correlations and descriptive statistics. The correlation matrix indicates that student self-efficacy, engagement, and achievement are positively associated. A path model was then tested including only autoregressive paths and concomitant residual correlations. This model indicated high stability coefficients between all constructs under investigation. The concomitant residual correlations were also all significant. Before assessing the following path-analysis models, a preliminary model was tested with student gender as a covariate and autoregressive paths. As suggested by Véronneau et al. (2010), nonsignificant paths between gender and any of the outcomes were removed. This led to keeping the paths between gender and self-efficacy in 5^{th} and 6^{th} grade. This association suggested that boys had higher levels of self-efficacy in math than girls.

Testing Self-Efficacy Theory

The Self-Efficacy Theory model (Fig. 2) reached an adequate fit to the data. Results indicated that self-efficacy and achievement both led to each other over time. The effect size of prior self-efficacy on later achievement was larger than the other way around. As shown in Table 3, self-efficacy mediated the association between prior and later achievement. This mediation was also significant the other way around. These results mostly confirm the hypothesis from Self-Efficacy Theory.

Testing the Self-System Model of Motivational Development

The Self-System Model model (Fig. 3) achieved a fit that was not as good as that of the Self-Efficacy Theory model. The Chi-square difference test confirmed that the Self-Efficacy Theory model had a better fit to the data ($\Delta\chi^2 = 36.81$, $\Delta df = 4$, $p < .001$). Of all the paths included in this model, only the associations between prior self-efficacy and later emotional engagement were significant. Moreover, behavioral and emotional engagement did not act as

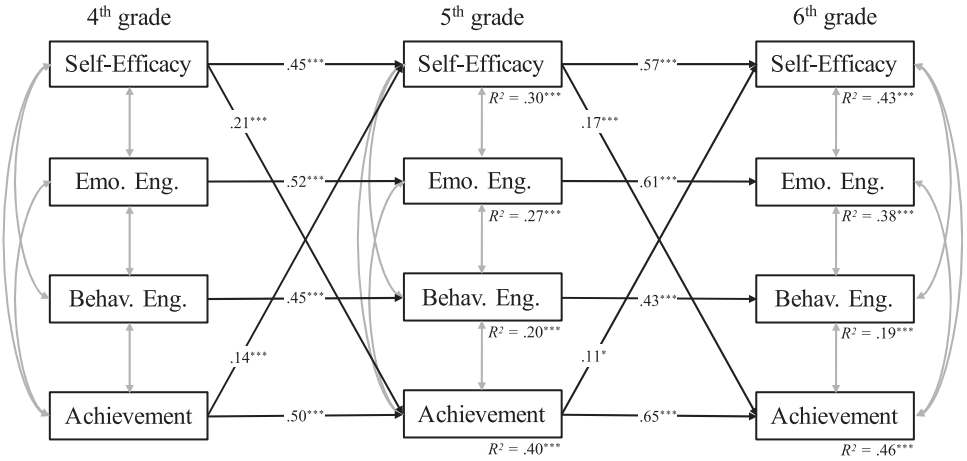

Fig. 2 Results for the Self-Efficacy Theory model. Standardized betas are displayed. Adjustment: $\chi^2 = 190.62$ ($df = 46$), $p < 0.001$, CFI = 0.93, TLI = 0.90, RMSEA = 0.07, SRMR = 0.10. Residual correlations are displayed in gray to enhance readability. $^{*}p < 0.05$. $^{**}p < 0.01$. $^{***}p < 0.001$

Table 3 Mediation paths tested with bootstrapped standard errors

Paths					ß	S.E.	p
Self-Efficacy Theory							
Self-eff.	→	Achiev.	→	Self-eff.	0.02	0.01	<0.050
Achiev.	→	Self-eff.	→	Achiev.	0.02	0.01	<0.050
Self-System of Motivational Development							
Self-eff.	→	Behav. Eng.	→	Achiev.	0.00	0.00	0.936
Self-eff.	→	Emo. Eng.	→	Achiev.	0.01	0.01	0.596
Final Model							
Self-eff.	→	Achiev.	→	Self-eff.	0.02	0.01	<0.050
Achiev.	→	Self-eff.	→	Achiev.	0.03	0.01	<0.050
Achiev.	→	Self-eff.	→	Emo. Eng.	0.03	0.01	<0.050

mediators between self-efficacy and achievement (see Table 3). Thus, the results did not support the assumptions of this theoretical framework.

Testing Expectancy-Value Theory

The Expectancy-Value Theory model (Fig. 4) had an adequate fit to the data. This model showed a better adjustment to the data than the Self-Efficacy Theory model ($\Delta\chi^2 = 21.06$, $\Delta df = 6$, $p < 0.01$) and the Self-System Model model ($\Delta\chi^2 = 57.86$, $\Delta df = 2$, $p < 0.001$). This model showed significant associations between prior self-efficacy and later emotional engagement at both times. Prior self-efficacy was also significantly associated with later achievement. Prior self-efficacy and emotional engagement were not associated with later behavioral engagement. Contrary to expectations, 5th-grade emotional engagement was negatively associated with 6th-grade achievement. This negative association may be an artifact of including other links in the model, as the correlations between emotional engagement and achievement were positive and significant. Also, this link was not significant between the 4th and 5th grade. Possible explanations are proposed in the discussion section.

Final Model

A final model was assessed relying on the significant links identified in the previous models. As the link between emotional engagement and achievement was negative between 5th and 6th grade, it was not included in the model. Results of this model are depicted in Fig. 5. This model was more performant than the Self-Efficacy Theory model ($\Delta\chi^2 = 28.58$, $\Delta df = 2$, $p < 0.001$) and the Self-System Model model ($\Delta\chi^2 = 65.38$, $\Delta df = 6$, $p < 0.001$), but not significantly better than the Expectancy-Value Model ($\Delta\chi^2 = 7.52$, $\Delta df = 4$, $p = 0.111$). As shown in this figure, student self-efficacy was associated with later emotional engagement and achievement at both time points. Prior achievement was also associated with later self-efficacy. Finally, as shown in Table 3, three possible mediations were tested. All three mediations yield significance. First, supporting Self-Efficacy Theory, self-efficacy mediated the association between prior and later achievement, and achievement mediated the association between prior and later self-efficacy. Although not grounded in any of the theoretical frameworks, achievement was also indirectly associated with later emotional engagement through self-efficacy.

Supplementary Analyses

In prior analyses, models were also tested with self-perceptions of mastery-motivation and relatedness to school. Results from these models were inconclusive. However, these measures of self-perceptions were not domain-specific, whereas other variables in the model were. The inconclusive results found in these models may reflect the scope of the measures and not an actual lack of associations. Hence, these models are not reported in this paper.

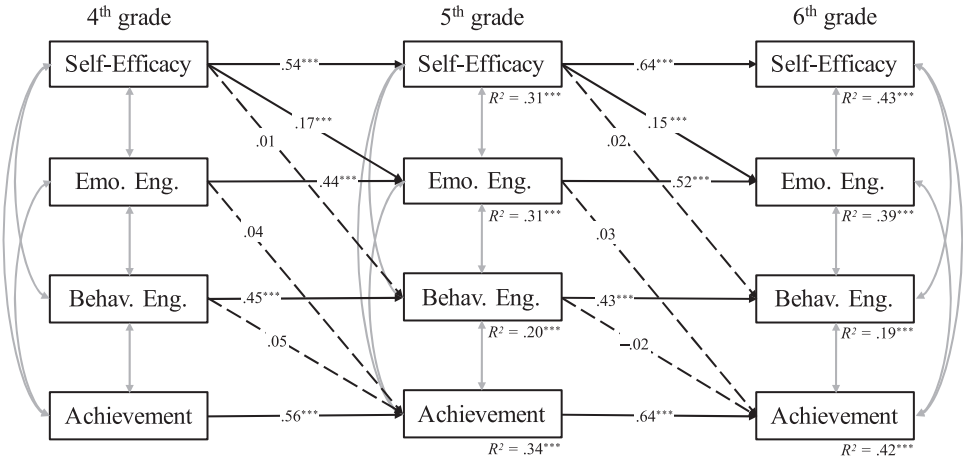

Fig. 3 Results for the Self-System model. Standardized betas are displayed. Adjustment: $\chi^2 = 227.40$ (df = 42), $p < 0.001$, CFI = 0.91, TLI = 0.86, RMSEA = 0.08, SRMR = 0.11. The dotted lines indicate non-significant paths. Residual correlations are displayed in gray to enhance readability. $^{*}p < 0.05$. $^{**}p < 0.01$. $^{***}p < 0.001$

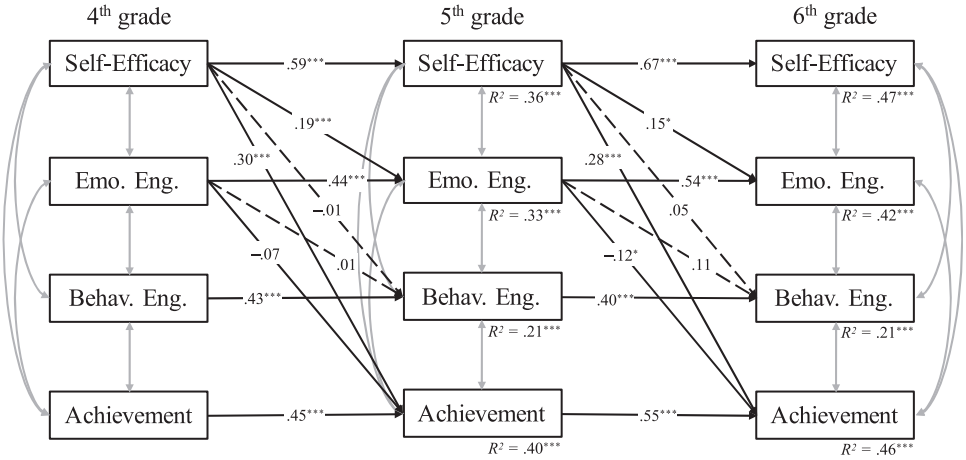

Fig. 4 Results for the Expectancy-Value Theory model. Standardized betas are displayed. Adjustment: $\chi^2 = 169.56$ (df = 40), $p < 0.001$, CFI = 0.94, TLI = 0.90, RMSEA = 0.07, SRMR = 0.09. The dotted lines indicate non-significant paths. Residual correlations are displayed in gray to enhance readability. $^{*}p < 0.05$. $^{**}p < 0.01$. $^{***}p < 0.001$

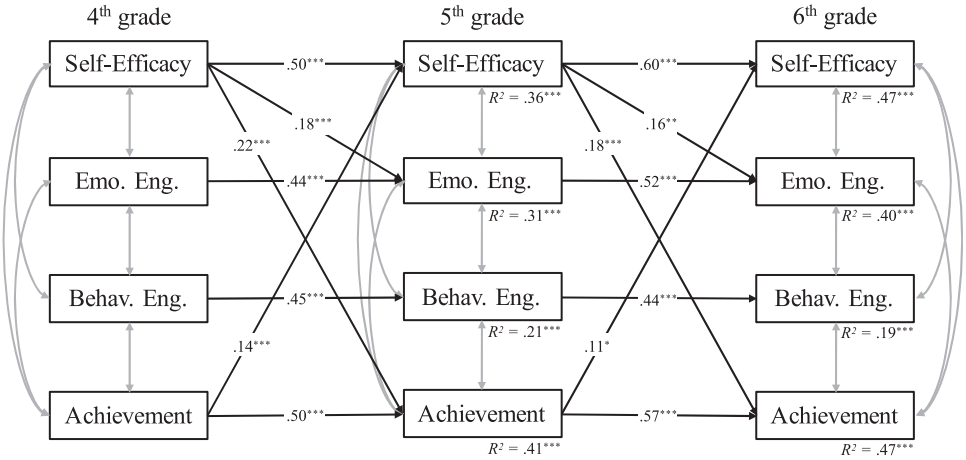

Fig. 5 Results for the Final model including paths identified in the previous models. Standardized betas are displayed. Adjustment: $\chi^2 = 162.04$ (df = 44), $p < 0.001$, CFI = 0.94, TLI = 0.91, RMSEA = 0.06, SRMR = 0.09. Residual correlations are displayed in gray to enhance readability. $^{*}p < 0.05$. $^{**}p < 0.01$. $^{***}p < 0.001$

Discussion

The developmental cascades leading to student academic achievement in math, a domain of prime importance in the elementary curriculum, is the focus of many theoretical and empirical inquiries. Student self-efficacy and classroom engagement are among the motivational factors most frequently investigated for their assumed role in this process. This study aimed at testing three alternative theoretical frameworks in the field of motivation, postulating different

developmental pathways leading to student academic achievement. Overall, results mainly support Self-Efficacy Theory and some of the assumptions of Expectancy-Value Theory, but not the Self-System Model. Student self-efficacy provided a clear contribution to emotional engagement and academic achievement one year later. Moreover, the links between student achievement and emotional engagement two years later appeared to be explained by perceived self-efficacy. Yet, the specific role of the behavioral dimension of engagement was more limited than expected. These findings are discussed in light of the three theoretical frameworks and existing empirical studies.

Self-Efficacy and Achievement

In line with the main hypothesis, an important finding is that the nexus between self-efficacy and achievement that was initially proposed by Self-Efficacy Theory was actually found in students from their 4th to 6th grades. Thus, student positive perception of efficacy in math has a long-lasting effect on their achievement and on the sustainability of this positive perception about themselves. The inverse is similarly true. The actual achievement of students also fueled their self-efficacy in math which, in turn, contributed to later performance. Other studies have found that self-efficacy is most strongly related to indicators of local rankings (e.g., teacher relative ranking of students within a class) than absolute rankings (e.g., standardized achievement tests) (Miller and Prentice 1996). This reciprocity between self-efficacy and achievement is mainly documented among older students by researchers relying on the model of self-concept otherwise known as the Reciprocal Effect Model (e.g., Marsh et al. 2016; Seaton et al. 2013). Adding to these self-concept-grounded investigations, this study shows that domain-specific self-efficacy can produce desirable results for student academic development and, in return, also be positively influenced by past achievement. As this mutual influence is consistently found across studies, researchers now have a valid proof that this reciprocal effect is representative of student motivational development (Arens et al. 2017; Marsh and Craven 2005).

The Role of Student Engagement

The Self-System Model and Expectancy-Value Theory add student engagement to the self-efficacy–achievement cascade. The Self-System Model suggests that student engagement explains the link between prior self-efficacy and later achievement (Connell 1990; Connell and Wellborn 1991). Yet, this process was not found from 4th to 6th grades in students who participated in this study. In contrast, Expectancy-Value Theory proposes that self-efficacy is a key determinant of both student emotional engagement (or task value, as named in this theory) and achievement, which is consistent with finding from this study and others (Li and Lerner 2013). As such, these results add to a somewhat established knowledge that students who report positive perceptions of their math abilities later feel more interested and enthusiastic when doing their assignments.

However, some of the links anticipated based on Expectancy-Value Theory were not found in this study. For instance, student self-efficacy and emotional engagement did not lead to behavioral engagement. In fact, even if behavioral engagement is a good indicator of student achievement-related choices (Wigfield et al. 2015), it was not explained by the feelings that students may have of being competent in math. This finding may suggest that other indicators of achievement-related choices should be investigated. For instance, participation, time on task, and doing homework are also part of behavioral engagement and, to some extent of achievement related-choices (Wigfield et al. 2015). Such behaviors were not investigated in this study but could have led to different conclusions.

Also, and most surprisingly, results from the Expectancy-Value Theory model indicate that student emotional engagement in 5th grade had a negative repercussion on their achievement in 6th grade. This may be an indication that the double-sword effect that others have found for student effort is also applicable to their emotional engagement (Covington and Omelich 1985; Marsh et al. 2016). This would mean that, if students are highly interested and enjoy learning math, but do not succeed at it, it may lead to negative outcomes on their grades. This hypothesized explanation has to be properly investigated in future studies, as it was not the case in this one.

In the Self-System Model model assessed in this study, student behavioral investment did not contribute to math achievement. This lack of association between behavioral engagement and achievement was surprising, especially as many studies conducted among elementary students support it (Dotterer and Lowe 2011; Ladd and Dinella 2009). However, these studies did not take self-efficacy into account. Self-efficacy could make the contribution of student behavioral engagement less central (Seaton et al. 2013). Again, investigating other behaviors may have led to different results. Participation, time on task, and doing homework are a few examples of behaviors found to contribute to student achievement beyond self-efficacy (Green et al. 2012; Valle et al. 2016).

An Unexpected Developmental Cascade

Probably the most important finding from this study was unexpected. Results suggest that a developmental cascade exists between student achievement and later emotional

engagement via self-efficacy. Thus, students who performed well in math were interested and enjoyed math two years later. This was explained by their feeling of being competent in this subject. Positive emotions in class are indicators that students are most likely to learn and engagement in classroom tasks for intrinsic reasons (Skinner et al. 2012). Such a developmental cascade may have positive repercussions for student academic well-being. Moreover, as stated in the introduction, Expectancy-Value Theory postulates that prior achievement feedbacks on student emotional engagement through self-efficacy. However, the link between prior achievement and later self-efficacy was not included in this model because Expectancy-Value Theory also states that it is student individual interpretation of success or failure, and not the actual result, that influences their self-efficacy (Eccles et al. 1983). Although individual interpretation may also be a mechanism, results from the present study indicate that the actual achievement of students directly related to their self-efficacy and, in turn, to their emotional engagement. This developmental cascade was also found in a study by Viljaranta et al. (2014) conducted in math among elementary students.

Why was The Self-System Model Not Supported?

In contrast with Self-Efficacy Theory and Expectancy-Value Theory that were globally supported by this study, the propositions of the Self-System Model were not. Although student self-efficacy led to later achievement, behavioral and emotional investment in math did not explain this association. A first explanation for the lack of support for this model is that the measures of student behavioral and emotional engagement relied on definitions proposed by Fredricks et al. (2004), which originated from a perspective put forward by Finn (1989) with students at risk of school dropout. Student behavioral and emotional disengagement is thus a collection of attitudes, behaviors, and thoughts leading to school withdrawal, which might be less directly related to student achievement than other important variables such as time on task (Reschly and Christenson 2012).

The second explanation, which needs to be put forward cautiously, is that the Self-System Model is not representative of elementary school student motivational development in math over the years. Among older students, such as university students, some studies have found this model to be valid (Dupont et al. 2014). With younger students, the direct links between self-efficacy or student engagement and achievement are widely supported, as stated previously. Yet, there are not as many studies that have assessed the link between prior self-efficacy and later engagement in school. Also, other studies that have tested cross-lag models with these three constructs do not support the assumptions of the Self-System Model (Marsh et al. 2016; Viljaranta et al. 2014). It may thus be that the rapid changes resulting from entering adolescence affect student motivational development (Wigfield et al. 2006). For example, young adolescents become increasingly sensitive to the influence of their peers (Padilla-Walker and Bean 2009). As a result, they may be more prone to comparing themselves to others. A measure of self-efficacy including an aspect of social comparison may have been of greater influence if assessed in the Self-System Model model. This remains to be investigated.

Moreover, as shown in the results, Self-Efficacy and Expectancy-Value Theories seem to posit developmental cascades that are representative of student development from one year to the next. The Self-System Model may be different in this respect, as this framework places great importance on the ability of students to relate to school and to people with whom they share frequent interactions (Connell and Wellborn 1991). On the one hand, it implies that the developmental process depicted is deeply anchored in a specific context, e.g., one classroom, with one teacher, one set of classmates, and their interrelationships (Skinner and Pitzer 2012). Therefore, the links between self-efficacy, engagement, and achievement described in this model might be observed within a school year but not across years, as that students change teachers and classmates. On the other hand, the Self-System Model proposes that two other self-perceptions (relatedness and autonomy) are key mechanisms explaining engagement and, in turn, achievement. Although this theory does not argue that the three self-perceptions are codependent in predicting engagement, not including relatedness and autonomy limits the conclusions drawn for this model.

Implications

Results indicate that the developmental cascades linking self-efficacy, classroom engagement, and academic achievement are more complex than postulated by theories. The reciprocal nature of these findings suggests that, when studying the effect of motivational factors on achievement, it is important to take past performance into account—which is usually done in longitudinal studies in this field of research—and to check for reciprocal effects—which is more rarely tested in the field. Moreover, simply assuming that propositions made by a theory are true because it has been tested in linear models is not enough. Studies must assess theoretical frameworks in a manner that allows the identification of reciprocal effects and comparison of assumptions with other frameworks. Results from this study ought to be replicated with different samples and time frames. Globally, these findings add to a growing body of evidence calling for a more careful assessment of the

respective contribution of the numerous motivational constructs leading to learning and achievement (Marsh et al. 2018).

At a practical level, teachers should strive to support self-efficacy which was a key contributor to emotional engagement and student achievement. More specifically, given that self-efficacy and achievement have far-reaching consequences on each other, students should have opportunities to succeed not only in their grades but also in day-to-day tasks. To feel efficacious, students can benefit from clear feedback on abilities and progress (Schunk and Pajares 2009; Wigfield et al. 2009). Also, as students feel more competent when they have experienced mastery of a specific task, teachers should allow students to familiarize themselves with new assignments and make sure that they understand the expectations (Schunk and Pajares 2009). Teachers should also ensure that each of their students has enough time and opportunities to practice and master the exercises proposed in class. This can be done, for example, by giving extra tasks to students who need it or encouraging students to help each other in the classroom. Finally, teachers should make sure that they dedicate special attention to individual progress (Schunk and Pajares 2009). Globally, this study suggests that student development in the school context is a complex interplay of motivational and achievement factors. Understanding them is not simple. Therefore, every prevention and intervention program should revolve around a particular effort to understand the motivational development of students as a complex, non-linear process that requires a wide range of supporting actions.

Limitations

First, although the measurement of student behavioral engagement was based on widely accepted definitions (Eccles and Wang 2012; Fredricks et al. 2004), as mentioned earlier, it did not include on-task behaviors. Having such complementary measures might have led to different conclusions. Also, even if teacher evaluation of student achievement is as performant as direct skill assessment (Duncan et al. 2007), student characteristics, such as behaviors, can still influence teacher perceptions (Smith 2007). Results from this study should be replicated using other measures of student achievement, e.g., standardized tests and official records. Moreover, the analysis did not account for the nested structure of data. Even though this study did not focus on environmental variables, students were grouped in different classrooms at each school year. This was not taken into account because of software limitations regarding the design of this study. In Mplus7, it is not possible to take into account a nested structure of data (type = complex) where individuals are cross-classified (type = crossclassified) in more than two types of groups. As students in this study were sorted in three different classrooms (one for each year), it was not possible to account for this sorting across school years. An alternative would have been to control for the nested structure of data on the first year (4^{th} grade). However, in this specific case, the models included too many parameters for the number of classrooms in the sample. Also, there was no control for contextual influences such as student socioeconomic status. Students in the sample came from a homogeneous background, which mitigates part of the bias but also limits the generalizability of findings. Finally, not all students have the same level of engagement and achievement. For example, students with adjustment difficulties usually feel less efficacious and engaged and are less successful in school (Olivier et al. 2018), a factor which was not accounted for. However, the tested models all included autoregressive paths, which control for past levels of the variables in the model, thus accounting for pre-existing lower levels of motivation and achievement due to student characteristics not included in the study.

Conclusion

The beginning of adolescence is a sensitive period for academic development. The rapid changes typical of this period can be quite unsettling in the life of youngsters. Even with an adequate adjustment, students are at increased risk of entering a downward trajectory of self-efficacy, engagement, and achievement (Wang and Eccles 2012; Wigfield et al. 2006). The academic achievement of young students is critical for their educational and professional success (Lewis et al. 2011; Shogren et al. 2017). It is thus important to understand the motivational development of young students, as it will help support their success in school. Theoretical models should thus guide researchers and practitioners in their pursuit of the best targets to support student achievement. However, few studies question and compare these models with the goal of identifying the best representation of the youth academic development. The current study is among the very few investigating three widely-accepted theoretical frameworks linking student self-efficacy, engagement, and achievement. Globally, this study confirms the hypothesis from Self-Efficacy Theory and some of Expectancy-Value Theory. Among students followed from their 4^{th} to their 6^{th} grade, self-perceived efficacy and teacher-reported achievement were closely tied, each contributing to the other over time. This finding adds to decades of investigations on the self-perception – achievement nexus (Arens et al. 2017; Marsh 1990). The original finding from this study is that student self-efficacy was a turning point between math achievement and

emotional engagement. Students who perform well in math are more likely to feel competent in this subject and then to enjoy assignments. Since emotional engagement is an indicator of student well-being and intrinsic value of learning (Skinner et al. 2012), identifying this developmental cascade provides new insight on what should support the positive experience of students while in school.

Authors' contribution EO conceived the study, analyzed and interpreted the data, and wrote the manuscript; IA provided the data, participated to the conceptualization of the study, to the analyses, and reviewed the manuscript; MD participated to the revision of the manuscript; BG participated to the conceptualization of the study and reviewed the manuscript. All authors read and approved the final manuscript.

Funding This research was supported by a grant from the Fonds québécois pour la recherche sur la société et la culture (FRQSC) (#131430), awarded to Isabelle Archambault and by a grant from the Social Sciences and Humanities Research Council (SSHRC) (#756-2017-0223), awarded to Elizabeth Olivier.

Data sharing and declaration The datasets analyzed during the current study are not publicly available but are available from the corresponding author on reasonable request and with permission of Dr. Isabelle Archambault.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in this study were approved by the ethics committee of the University of Montreal. This research complies with APA's ethical standards in the treatment of human samples and with the highest ethical standards.

Informed consent Active informed consent was obtained from all individual participants included in the study, both teachers and students. Parents also gave their active consent for their child to participate.

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Elizabeth Olivier is a postdoctoral researcher at the Université catholique de Louvain (Belgium), Departement of Psychology and Educational Sciences. She received her Ph.D. from the Université de Montréal (Canada). Her main research interest focus on the motivational development of students without and with adjustment problems, as well as on teacher need-supportive practices.

Isabelle Archambault is a professor at Université de Montréal (Canada), School of Psychoeducation. She holds the Canada Research Chair on School, Child Well-Being, and Educational Success. She is also a member of the Research Group on School Environment (Montréal, Canada) and of the Université de Montréal Public Health Research Institute. Her research interests focus upon the differential effects of school or its practices on the engagement, well-being, and educational success of youth from vulnerable population. Her special focus is on students from low-socio-economic families, immigration, and with academic or mental health problems.

Mikael De Clercq is a postdoctoral researcher at the Université catholique de Louvain (Belgium), Departement of Psychology and Educational Sciences. He received his Ph.D. from the same university. His research interests focus on student experience of academic transition in the first year of university and in the doctoral studies.

Benoit Galand is a full professor at the Université catholique de Louvain (Belgium), Department of Psychology and Educational Sciences. He received his Ph.D. in Psychology from the same university. His major research interests include motivation and engagement, school violence and bullying, and teaching practices.