García, T., Rodríguez, C., Betts, L., Areces, D., & González-Castro, P. (2016). How affective-motivational variables and approaches to learning relate to mathematics achievement in upper elementary levels. *Learning and Individual Differences, 49,* 25-31.

Abstract

The relationship between students´ motivation and attitudes towards mathematics, the approaches to learning they use, and their achievement in mathematics has been widely documented in middle school and further academic levels. However, the empirical research in earlier educational stages remains scarce. This study analyzed the predictive value of affective-motivational variables and deep and surface approaches to learning on mathematics achievement in a sample of 524 upper elementary students. Multiple linear regression analysis was used to examine the predictors of mathematics achievement. Mathematics enjoyment positively predicted mathematics achievement and age and the use of the surface approach to learning negatively predicted mathematics achievement. The variables in the model explained 21.3% of the variance in mathematics achievement. Mean differences in the affective-motivational variables and approaches to learning occurred between students with very high and very low achievement in Mathematics, yielding further evidence of important differences between the achievement extremes.

Keywords: achievement, affective-motivational components, approaches to learning, elementary school, mathematics.

1. Introduction

Numerous studies have examined the determining factors of academic achievement in mathematics (e.g., Bodovski & Young, 2011; Villavicencio & Bernardo, 2013). This interest is driven by the relevance of mathematics for both formal education and everyday life (Jansen et al., 2013). However, from the very early years of education, many students face failure in mathematics. Students´ affective-motivational components (i.e., motivation, self-efficacy beliefs, enjoyment, anxiety, and perceived usefulness or value of mathematics) and the strategies they use to learn mathematics (i.e., approaches to learning) impact on their achievement, regardless of their cognitive ability or previous knowledge (Kember & Watkins, 2010; Murayama, Pekrun, Lichtenfeld, & vom Hofe, 2013; Steinmayer & Spinath, 2009).

A brief description of these components and the findings from previous research that has examined the relationship between affective-motivational variables, approaches to learning, and mathematics achievement, are presented below. Following Tapia and Marsh's (2004) model, which differentiates between the affective-motivational components of value, self-efficacy, motivation, and enjoyment (Tapia & Marsh, 2004; Lim & Chapman, 2013), the present study includes an additional component: Mathematics anxiety. Two main approaches to learning are examined in the current study: Deep and Surface (Biggs, 1987).

1.1. Affective-motivational components and mathematics achievement

Previous studies report that students experience a wide range of emotions whilst engaged in learning situations. Consequently, affective-motivational components do not simply refer to liking or disliking mathematics but rather the perceived usefulness or value of mathematics, mathematics self-efficacy, intrinsic motivation, mathematics anxiety, and enjoyment.

Perceived usefulness

Also called "value", perceived usefulness refers to students' beliefs about the practical use and applicability of mathematics currently and in relation to their future (Adelson & McCoach, 2011). Perceptions of high value are associated with the acquisition of new knowledge (Guy, Cornick, & Beckford, 2015). Students who perceive mathematics as useful are more motivated to learn, practice, study, and employ key self-regulatory strategies than students who perceive mathematic as less useful (Cleary & Chen, 2009; Kajamies, Vauras, & Kinnunen, 2010; Villavicencio & Bernardo, 2013; Zimmerman & Schunk, 2008).

Mathematics self-efficacy

Characterized by Bandura (1977, 1997) as a person's belief in his or her capacity to execute behaviors necessary to achieve specific goals, self-efficacy is understood as an important aspect of learning. According to Fennema and Sherman’s (1976) model, this component can be defined as the confidence in learning mathematics. Thus, mathematics self-efficacy refers to students’ perception of themselves as learners and their capacity to succeed with mathematics. Numerous studies have found that students with low self-efficacy beliefs tend to avoid tasks involving mathematics whereas students with higher self-efficacy beliefs often show greater interest and persistence which leads to higher achievement (Berger & Karabenick, 2011; Rosário et al., 2012).

Intrinsic motivation

Intrinsic motivation is characterized by the tendency to engage in a task for the sake of interest in the task itself and the inherent pleasure derived from learning (Murayama et al., 2013). Under the influence of intrinsic motivation, the quality of the knowledge acquired by students is greater (Lambic & Lipkovski, 2012; Murayama et al., 2013; Schunk, Pintrich, & Meece, 2008; Villavicencio & Bernardo, 2013).

Mathematics anxiety

This concept refers to the experience of extreme discomfort when doing or even thinking about mathematics (Yaratan & Kasapoğlu, 2012). Mathematics anxiety is one of the most important determinants of a student’s lack of success in mathematics (Ahmed, Minnaert, Kuyper, & Van der Werf, 2012). Students with mathematics anxiety are nervous about mathematical situations and try to avoid such environments, reducing their motivation and engagement in these tasks (Jansen et al., 2013; Yaratan & Kasapoğlu, 2012). Ashcraft, Krause and Hopko (2007) and Krinzinger, Kaufman and Willmes (2009) suggest that the relationship between mathematics anxiety and achievement can be explained by the role of working memory. Specifically, higher levels of mathematics anxiety are associated with shorter working memory span in laboratory tasks which causes (among others) a reduced capacity to perform the necessary calculations or processes at the required level of accuracy. The relevance of anxiety emerges from the fact that, while mathematics anxiety can appear at any educational level, once established it can persist for a long time leading students to avoid mathematics-related courses and future career avenues (Ahmed et al., 2012; Yaratan & Kasapoğlu, 2012).

Enjoyment of Mathematics

In the context of mathematics, enjoyment is defined as the degree to which a person takes pleasure in doing and learning the subject (Adelson & McCoach, 2011). As Lambic and Lipkovski (2012) argue, motivation derived from the enjoyment of mathematics seems to have a greater influence on achievement than the other affective-motivational components. Similarly, Villavicencio and Bernardo (2013) report that enjoyment serves as a positive predictor of achievement in mathematics and that enjoyment is also related to self-regulatory mechanisms. According to these authors, this relationship reflects the fact that positive emotions such as enjoyment, hope, and pride, have been demonstrated to boost the use of flexible learning strategies and self-regulation skills, and the availability of cognitive resources for task engagement.

1.2. Approaches to learning and mathematics achievement

Another important variable that predicts learning outcomes is students´ approaches to learning (Furnham, Monsen, & Ahmetoglu, 2009; McInerney, Cheng, Mok, & Lam, 2012; Murayama et al., 2013; Sengodan & Zanaton, 2012). Approaches to learning are characterized as the methods used by an individual to focus on and retain new information (Sengodan & Zanaton, 2012). There are many classifications of this construct. One such classification provided by Selmes (1987) distinguished between five approaches to learning in mathematics: deep, surface, organization, motivation, and hard work. However, it is not clear which components within Selmes' classification refer to strategies, attitudes, and motivation. Therefore, the present study adopted Biggs´ (1987) framework. Biggs' framework is one of the most widely accepted classifications and has been shown to have better conceptual and predictive value than other such frameworks (Kember & Watkins, 2010; McInerney et al., 2012; Murayama et al., 2013). It differentiates between two types of strategies that students can adopt to learn: *Deep* and *Surface*.

Deep approach to learning

Through elaborating the materials to be learnt, learners attempt to integrate new information with prior knowledge, organize new information, relate ideas, and monitor their understanding of the information. This pattern of learning is commonly translated into better performance (McInerney et al., 2012). Adopting a deep approach to learning implies a semantic understanding of the information which is assumed to be an essential component in acquiring meaningful and long-term knowledge (Murayama et al., 2013).

Surface approach to learning

This approach involves rote memorization of material without deep elaboration. This kind of learning is characterized by the repetitive rehearsal of the information. Contrary to deep strategies, the goal of studying is simply to fulfill situational demands (e.g., getting the assignments done or the courses passed) or to obtain external reinforcements (e.g., praise or gifts). As a result, the knowledge acquired via a surface approach fades quickly (McInerney et al., 2012; Murayama et al., 2013). As Murayama noted, for students who aim to pass, surface strategies may allow them to "survive" tests and examinations with minimal effort but such strategies will lead to low-quality learning.

Previous studies suggested that both Deep and Surface approaches to learning are predictive of achievement in mathematics, but in an opposite way. Specifically, deep approaches to learning lead to higher levels of achievement and more durable learning, whereas surface approaches are predictive of lower levels of achievement (Baeten, Kyndt, Struyven, & Dochy, 2010; Mclnerney et al., 2012; Yaratan & Kasapoğlu, 2012).

1.3. Conclusions from the previous research

The previous research findings exploring approaches to learning, together with the previously described relationship between affective-motivational variables and mathematics achievement, suggest the need to properly examine these factors. However, most previous research examining these relationships has been conducted in adolescent samples (Baeten et al., 2010; Pennebaker, Gosling, & Ferrell, 2013; Sengodan & Zanaton, 2012). This is even more evident in the case of approaches to learning, where the very few studies that have been conducted in younger samples have commonly described these components as an indeterminate set of predispositions such as persistence, emotion regulation, or attentiveness, rather than emphasize the strategic nature of this construct (Bodovski & Youn, 2011; Li-Grining, Votruba-Drzal, Maldonado-Carreño, & Haas, 2010; Malmberg, Järvernoja, & Järvelä, 2013). Thus, further research is needed with younger students that extends this line of research. In this sense, a developmental period that warrants particular consideration is the last years of elementary school. Upper elementary school is an important stage in a child's educational career because it supports the transition to secondary or middle school, a time when students tend to describe mathematics as less interesting or valuable and report lower effort and persistence (Adelson & McCoach, 2011; Sakiz, Pape, & Woolfolk, 2012; Waters, Cross, & Runions, 2009). Examining these components and their relationship in this stage could provide an interesting path to prevent further school maladjustment and negative attitudes towards mathematics.

1.4. The present study

Within this context, the present study examined whether the five affective-motivational variables described above and the use of deep and surface approaches to learning predicted mathematics achievement in a sample of fifth- and sixth-grade Spanish students. Based on previous research, it was expected that these variables would significantly predict students´ achievement in mathematics in the following direction: (1), higher levels of Perceived usefulness, Perceived self-efficacy, Intrinsic Motivation, Enjoyment, and the use of a Deep approach to learning would predict higher mathematics achievement; and (2), higher levels of Mathematics anxiety and the use of a Surface approach to learning would predict lower mathematics achievement. Age, gender, and grade level were also included in this analysis in order to control for their possible effects on mathematics achievement. Additional analyses were undertaken to examine whether there were mean differences between students with very different levels of achievement in mathematics (i.e. those very high and very low achieving students). In this sense, statistically significant differences were expected to be found between the two groups, replicating the relationships observed in the regression analysis.

2. Material and Methods

2.1. Participants

Five hundred and twenty-four students, from 12 primary schools in northern Spain, took part in this study. Their ages ranged between 10 and 13 years (M = 10.99, SD = 0.716). Of these students, 49.6% were female (n = 260). The sample comprised 220 students from the 5th grade (42%; male = 108, female = 112), and 304 students from the 6th grade (58%; male = 156, female = 148) of elementary school. Data from the whole sample were used in the regression analyses.

Data from 175 students were used to examine differences between those with very high and very low levels of achievement. Students were assigned to one of the achievement groups according to their final academic marks in mathematics, which ranged from 3 to 10 in the present sample (M = 6.508; SD = 2.712). Students with academic marks of 3 or 4 were assigned to the low-achieving group (Group 1; n = 58); while those who had marks of 9 or 10 were classified as high-achieving students (Group 2; n = 117). A mark of 4 equates to a fail in the current Spanish educational system, while marks that equal or over 9 indicate very high achievement. These score ranges were selected in order to guarantee that students in the different groups performed differently in mathematics. There were no differences between the groups with regards to age (p= .425), gender (p = .113), or grade level (p = .912). Age was included, however, as a covariate in the analysis of the mean differences between groups.

Sample selection was made through convenience procedures. Students volunteered for the study and presented parents´ informed consent. Children with a diagnosis of severe learning disabilities or low intellectual ability were excluded from the analyses.

2.2. Variables and instruments

2.2.1. Affective-motivational components: Perceived usefulness of mathematics, Mathematics self-efficacy, Intrinsic motivation, Mathematics anxiety, and Enjoyment of mathematics were assessed though the *Inventory of Attitudes toward Mathematics- IAM* (Cueli, García, & González-Castro, 2013). Based on the Fennema-Sherman Mathematics Attitude Scales (Fennema & Sherman, 1976), the IAM contains 86 items assessing 15 primary dimensions. Only five subscales were administered in this study: Perceived usefulness (e.g., “I think mathematics will be useful to me in the future”), perceived self-efficacy (e.g., “I´m sure I can learn mathematics”), intrinsic motivation (e.g., “I like solving difficult problems”), Mathematics anxiety (e.g., “I´m afraid of mathematics exams”), and enjoyment (“I enjoy studying mathematics”). Each subscale comprised 4 items. Participants responded to the items using a 5-point Likert (from 1 =*strongly disagree,* to 5 =*strongly agree*). The Cronbach´s alphas of the five scales used ranged between .84 and .86.

2.2.2. Approaches to learning: Deep and Surface approaches to learning were assessed using the *Processes Study Inventory-PSI* (Núñez et al., 2011; Rosário et al., 2007, 2012). The scale comprises 12 items that represent the 2 dimensions with 6 items per component. The items were positively worded and scored on a 5-point Likert-type format (from 1 = *never,* to 5 = *always*). Cronbach’s alphas were .72 and .70 for the deep (e.g., “I try to understand what I´m studying”) and surface dimensions (e.g., “I only study to pass”), respectively. Although not excellent, these coefficients are higher than those found with similar tools, such as Biggs’ Learning Process Questionnaire (LPQ; Biggs, Kember, & Leung, 2001).

2.2.3. Mathematics achievement: this variable was created based on the students’ final academic marks in mathematics and ranged from 3 to 10. Mathematics achievement was used: (1) as a continuous variable for regression analyses and (2) to distinguish between two groups with very different levels of achievement for mean differences analyses (i.e., very low and very high achieving groups, as outlined in the participants section).

2.3. Procedure

This study was conducted in accordance with The Helsinki Declaration of the World Medical Association (Williams, 2008), which reflects the ethical principles for research involving humans. The questionnaires were collectively administered in a regular mathematics class and the students voluntarily participated in the study. After completing the study, a report with the main findings and suggestions was prepared and handed to the teachers. Given that final marks in mathematics were used as a measure of academic achievement in the subject, the surveys were administered during the second school semester.

2.4. Data analysis

SPSS v.19 (Arbuckle, 2010) was used to carry out the statistical analyses. Data were analyzed in four steps: first, descriptive statistics for the studied variables were provided, in order to verify they met normality criteria (see Table 1). Considering Finney and Di Stefano’s (2006) criterion, where ±2 and ±7 are the maximum allowable values for skewness and kurtosis, all the variables met these criteria. Pearson´s correlations among the five affective-motivational variables, approaches to learning, and students´ achievement in mathematics were examined, since a condition to conduct regression analyses is the existence of an association among variables. Statistically significant correlations were found, as Table 1 shows. Next, a multiple linear regression analysis was conducted to determine the predictive value of the affective-motivational variables and approaches to learning on mathematics achievement. Gender, grade level and age were also included as potential predictors. Grade level and gender were dummy-coded. The variables were entered in three different blocks in order to examine the relative contribution of each group of variables in explaining the total variance in Mathematics achievement. In Block 1 of the regression, the covariates Age, Gender and Grade level were entered; in Block 2, the five affective-motivational variables were introduced; and in Block 3, the Deep and Surface approaches to learning were included (Table 2). Finally, a Multivariate Analysis of Covariance (MANCOVA) was carried out to analyse the mean differences between students with very different levels of achievement in Mathematics (i.e. very low and very high achieving groups). Age was included as a covariate. As the MANCOVA showed the existence of statistically significant differences between the groups for all of the variables, the results from multivariate contrasts (per each individual variable) were interpreted (Table 3). Differences were considered as statistically significant only at the level of $p \leq .05$. To interpret effect sizes, Cohen´s (1988) criterion was used, which establishes that the effect is small when $\eta p^2 = .01$ ($d = .20$), medium when $\eta p^2 = .059$ ($d = .50$), and large when $\eta p^2 = .138$ ($d = .80$).

Table 1. Descriptive statistics for the variables and the Pearson´s correlations among the variables.

	1	2	3	4	5	6	7	8
1.Perceived usefulness	—	.310**	.178**	-.264**	.274**	.106*	-.141*	.173**
2.Mathematics self-efficacy		—	.492**	-.417**	.453**	.190**	-.123**	.198**

3.Intrinsic motivation			—	-.440**	.348**	.324**	-.135**	.192**
4.Mathematics anxiety				—	-.530**	-.109*	.189*	-.240**
5.Enjoyment					—	.140**	-.137**	.254**
6.Deep approaches						—	-.175**	.136**
7.Surface approaches							—	-.366**
8.Mathematics achievement								—
Mean	16.623	16.712	14.206	8.907	14.207	22.170	15.238	6.508
SD	4.165	3.134	3.529	3.840	2.217	3.704	4.317	2.712
Skewness	1.118	-.755	-.481	.711	-.558	.345	.393	-.290
Kurtosis	.953	.582	-.160	-.129	.334	.578	.015	-.771

*$p \leq .05$ (2-tailed), **$p \leq .01$ (2-tailed)

3. Results

3.1. Affective-motivational variables and approaches to learning predicting mathematics achievement

Table 2 shows the results from the regression analysis. Through entering the variables in different blocks it was possible to determine the unique contribution of each group as predictors of Mathematics achievement.

As Table 2 shows, concerning the covariates, only age acts as a statistically significant predictor of Mathematics achievement at the first step of the analysis. The total variance accounted for by all three variables entered in the first block was non-significant, $F(3,497) = 5.497$, $p = .254$. When the second block of variables -comprised of the five affective-motivational components- was entered, Age, Mathematics anxiety, and Enjoyment significantly predicted Mathematics achievement. The percentage of variance of Mathematics achievement that was explained was 11% and was statistically significant, $F(8,492) = 7.619$, $p < .001$. The change in the amount of variance explained due to affective-motivational variables was also significant, $F(5,492) = 11.004$, $p < .001$. Finally, when the Surface and Deep approaches to learning were entered in the third block, the explained variance changed from 11 to 21.3 %, an increase that was statistically significant, $F(2,490) = 31.989$, $p < .001$. Age and the Surface approach to learning negatively predicted Mathematics achievement such that older students and those who adopted a surface had lower mathematics achievement. Enjoyment of mathematics positively predicted mathematics achievement: Greater enjoyment of mathematics predicted higher achievement. It is important to note at this point that in the final model anxiety was not significant even though it was in the second model.

Table 2 Results from Multiple Linear Regression. Standardized Coefficients and explained variance.

	Block 1		Block 2		Block 3	
	Beta	*t*	*Beta*	*t*	*Beta*	*t*
Constant		5.620***		3.605***		4.889***
Age	-.140	-2.280*	-.148	-2.507*	-.136	-2.454*
Grade level	.108	1.761	.121	1.037	.070	1.250
Gender	.018	.411	-.001	-.030	.024	.603
Perceived usefulness			.080	1.745	.052	1.208
Mathematics Self-efficacy			.026	.493	.024	.474
Intrinsic Motivation			.079	1.544	.048	.944
Mathematics anxiety			-.105	-1.946*	-.066	-1.281
Enjoyment			.147	2.763**	.136	2.713**
Deep approaches					.028	.647
Surface approaches					-.328	-7.795***
R^2	.001		.110***		.213***	
ΔR^2			.100***		.103***	

Note. Variables entered in different blocks.
Dependent variable: Mathematics achievement. Explained variance (R^2) and change (ΔR^2).
$*p \leq .05$. $**p \leq .01$. $***p \leq .001$

3.2. Mean differences in affective-motivational variables and approaches to learning for students at the extremes of achievement

Table 3 shows means, standard deviations, and statistical significance of the differences between the groups with very low and very high achievement levels. These results suggest that very high achieving students systematically report higher levels of Perceived usefulness of mathematics, Mathematics self-efficacy, Intrinsic motivation, and Enjoyment, as well as a preference for a Deep approach to learning compared to their low-achieving peers. Very high achieving students also indicated that they feel less Anxiety, and use a Surface approach to learning less frequently than the very low achieving group. Results from the MANCOVA shows that collectively these differences were statistically significant, with a large effect size, λ *Wilks* = .349; $F(7, 166) = 12.698$; $p < .001$; $\eta p^2 = .349$. Age was not a statistically significant predictor ($p = .424$). Multivariate contrasts indicated that there were also statistically significant differences between groups in each studied variable when considered separately. The most important differences were found in the Surface approach and Enjoyment, which showed the largest effect size.

Table 3. Means, Standard Deviations and differences between the students at the extremes of Mathematics achievement

	Group 1	Group 2	Differences	
	M(SD)	*M(SD)*	*F(2.172)*	ηp^2
1. Perceived usefulness	14.8533 (3.834)	17.272 (3.108)	19.697 ***	.103
2. Mathematics Self-efficacy	15.601 (3.425)	17.420 (2.452)	16.885 ***	.089
3. Intrinsic motivation	13.273 (3.505)	15.159 (3.466)	11.559 ***	.063
4. Mathematics anxiety	10.476 (4.439)	7.792 (3.570)	19.691 ***	.103
5. Enjoyment	13.169 (2.832)	14.877 (1.597)	26.800 ***	.135
6. Deep approach	21.388 (4.319)	22.874 (3.764)	5.833 *	.033
7. Surface approach	17.671 (4.138)	12.912 (3.529)	62.753 ***	.267

Note. Means are covariate-adjusted, using age as a covariate.
Group 1 = low achievement ($n = 58$); Group 2 = high achievement ($n = 117$).
$^*p \leq .05$, $^{**}p \leq .01$, $^{***}p \leq .001$

4. Discussion and conclusions

The present study examined the predictive value of five affective-motivational variables and deep and surface approaches to learning on mathematics achievement in a sample of fifth- and sixth-grade students from northern Spain. The main goal of this study was to comprehensively analyse this relationship in elementary school settings, in which research on this topic still remain scarce.

Findings obtained in the present study partially supported the initial predictions, with the whole set of variables explaining a small but significant amount of variance in mathematics achievement. Though all variables were significantly correlated with math achievement, in the regression analysis with all of the variables together only age, enjoyment, and surface approaches to learning were statistically significant predictors. Specifically, as students' enjoyment in mathematics increased so too did achievement. Conversely as age and the tendency to use surface approaches increased mathematics achievement decreased. This relationship between affective-motivational variables, approaches to learning, and academic achievement was also elicited when the mean differences between students with very different levels of achievement were compared. These findings are consistent with previous international research conducted in different educational stages, which reported the significant predictive value of affective-motivational variables such as learning attitudes, learning habits, and academic motivation, on mathematics achievement (e.g., Kassim, Abisola, & Adeyanju, 2011; Moenikia & Zahed-Babelan, 2010; Veloo, Ali, & Krishnasamy, 2014). The total amount of variance of academic achievement explained by all variables included in the present study was 21.3%; whereas these figures range from 2 to 33% in previous studies. For instance, in the study conducted by Veloo et al. (2014) with 250 students from three public technical secondary schools in Malaysia, learning attitude and anxiety explained a 17.4% of the variance in mathematics achievement. In the context of the present study, it is worth noting that the change in the variance explained by the model increased significantly (from 10 to 21.3%) when approaches to learning were considered. These results call for examining these components from early stages, where references on this topic are limited to date.

It is also interesting to note that the use of a surface approach to learning significantly predicted achievement. At this point, it is necessary to consider that the approach that has received more attention from previous literature is the deep approach to learning (Chen & McNamee, 2011; De la Rosa & Bernardo, 2013; McInerney et al., 2012; Murayama et al., 2013; Shield & Dole, 2013). In this context, the longitudinal study conducted by Murayama et al. (2013) is noteworthy. These authors reported that both deep and surface approaches were related to long-term growth in mathematics achievement but the nature of the relationship was different: the use of a deep approach to learning were positively linked, whereas the use of a surface approach to learning were negatively linked to this improvement. Further, surface learning strategies were also negatively linked to initial levels of achievement. These results, along with the findings from the present study (i.e., absence of predictive value of the deep, and saliency of the surface approach to learning), may be partially explained by the way in which mathematics achievement was assessed (i.e., based exclusively on academic marks). Although academic marks are one of the most used criterion to determine a student´s achievement at school, academic marks not always capture the actual knowledge that an individual has, as they are commonly based on exam scores rather than the evaluation of strategy use and competences. This is one of the limitations that this study and some previous studies should acknowledge. The greater relevance granted to academic marks by educators, students, and also our society (which seems to increase as a student progresses towards further educational levels), may be another aspect to consider in this sense. Students´ learning experiences and the characteristics of classroom environments nowadays may also be enhancing the use of a surface approach to learning (Sengodan & Zanaton, 2012). As these authors pointed out, students at these levels are commonly used to waiting for instructions and memorizing information, instead of focusing on information understanding and re-elaboration. These working patterns may be increasing the prominence of a surface approach to learning in these contexts.

On the other hand, the relationship between mathematics achievement and enjoyment that was found in the present study suggests the relevance of attitudes and motivations in learning. This relationship had been highlighted in previous studies (e.g., Ahmed et al., 2012; Ashcraft et al., 2007; Jansen et al., 2013; Krinzinger et al, 2009; Villavicencio & Bernardo, 2013; Yaratan & Kasapoğlu, 2012). These studies demonstrate that students who enjoy learning mathematics tend to exert more effort and persist for longer even when they struggle with difficult tasks, which leads to an increase in their success rates.

Finally, the role of age as a significant predictor of mathematics achievement in this study must also be considered. This variable exercised a negative effect on mathematics achievement (i.e., the older the students, the lower the academic achievement). This result may be related to the sample studied which comprised 10 to 13 year-old students. As Sakiz et al. (2012) argued, students of this age commonly struggle with mathematics. For these authors, this period coincides with the transition to middle school, in which the mismatch between students´ interests and values and the new academic requirements increases which, in turn, may lead to lower academic engagement, less perceived educational value, and a declining motivation to study mathematics. This pattern commonly correlates to academic failure in the subject.

4.1. Practical implications

Although other factors such as prior knowledge, contextual and personal characteristics may also explain differences in mathematics achievement, the findings from the present study highlight the need to pay attention to affective-motivational and strategic components of students at these educational levels, in which they start to develop attitudes (e.g., whether they enjoy mathematics, the value they attribute to learning mathematics, etc.) and construct a self-perception as learners (Adelson & McCoach, 2011; Beausaert, Segers, & Wiltink, 2013; García, Kroesbergen, Rodríguez, González-Castro, & González-Pienda, 2015; Sakiz et al., 2012; Waters et al., 2009). Since these components can be responsible for students´ further effort and persistence in mathematics, attention and support provided by teachers may also be critical. In this sense, Sakiz et al. (2012) found significant associations between students´ perception of teachers´ affective support and their motivational, emotional, and behavioural outcomes in a sample of 7^{th} and 8^{th} graders from 5 public middle schools. Perception of teachers´ support also explained a significant proportion of variance in students' sense of belonging, academic enjoyment, self-efficacy beliefs, academic hopelessness, and effort in mathematics. Likewise, it is necessary to try and promote appropriate learning styles at school and home, and understand students´ individual differences in learning. The personalization of learning agenda or the use of personalized resources, such as hypermedia tools, would be an interesting approach in this sense. This sort of strategy enhances motivation, which is translated into engagement and persistence, in both low achievers and (highly) able learners (Hollingworth, Allen, Hutchings, Abol-Kuyok, & Williams, 2008; Lopez-Moreto & Lopez, 2007; Walls & Little, 2005).

4.2. Limitations

It is necessary to acknowledge some limitations in the present study: first, although statistically significant, the variables in the final model accounted for a relatively small percentage of the variance of mathematics achievement. This suggests that additional variables should be included in future studies. Second, previous research has shown that a student´s approach to learning may not be stable, changing in response to task characteristics, learning environments, or personal features (Aharony, 2006; Ahmed et al., 2012; Azer, Guerrero, & Walsh, 2013; García, Cueli, Rodríguez, Krawec, & González-Castro, 2015). It would be necessary to examine this component in a wider range of situations to better delimit its relationship with academic achievement; third, the results from the present study cannot provide evidence about the directionality of the relationship among variables. More complex designs, of experimental or longitudinal nature, will be necessary in order to examine this aspect properly. Finally, and in order to improve knowledge of the determinants of mathematics achievement, other components such as prior achievement, subject and environmental features, must be considered in further studies. It would also be interesting to examine the extent to which the affective-motivational variables and approaches to learning analysed in the present study relate to academic achievement using another –and deeper- criterion but not just marks as a measure of academic achievement.

Acknowledgments: Grants awarded to the authors from the Spanish Ministry of Science and Innovation (Ref.: EDU2010-19798) and the program "Severo Ochoa" of the Principality of Asturias (BP11-067, and BP14-030) supported this work.

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