



Relations among competence beliefs, utility value, achievement goals, and effort in mathematics

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Background. Research has shown that motivation is a key factor in the learning process as well as in school achievement. In essence, a number of researchers have highlighted the close link between motivation and achievement-related behaviours such as effort.

Aims. The present study aims to acquire more specific information concerning the relations between competence beliefs, utility value and achievement goals in mathematics among secondary school students, to further document the influence of social agents, and to better understand the relationships between these variables, as well as to effort.

Sample. Participants were 759 Grade 7 to Grade 11 students (389 males, 370 females).

Method. Structural equation modelling techniques were used to test a model of achievement-related behaviours (effort) in mathematics based on support from social agents, competence beliefs, utility value and achievement goals. Several self-reported scales were administered.

Results. Results indicate that effort in mathematics is mainly explained by mastery goals and competence beliefs. As for the role of social agents, results demonstrated that the perception of parental support chiefly explained variables associated with the valuing of mathematics while teachers' support acted most on competence beliefs.

Conclusions. Two main conclusions stem from our results. First, mastery goals have an important and significant impact on students' effort in the learning of mathematics. Second, the nature and the strength of the relationships between competence beliefs, utility value, achievement goals and effort are not significantly influenced by age and gender, at least in mathematics.

Research has shown that motivation is a key factor in the learning process as well as in school achievement (Pintrich & Schunk, 1996). In essence, a number of researchers have highlighted the close link between motivation, achievement-related behaviours, such as effort and achievement (Bandura, 1997; Pintrich & Schunk, 1996; Shernoff,

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Csikszentmihalyi, Schneider, & Shernoff, 2003). In particular, some variables, such as competence beliefs and value ascribed to academic tasks and domains have been the focus of numerous studies. Some researchers also highlighted the impact of parental support and teachers on student motivation (Grolnick, Gurland, Jacob, & Decourcey, 2002; Wigfield & Eccles, 1992). More recently, achievement goals of students were also under scrutiny, with often mixed, inconclusive results. Although there is empirical evidence supporting the relevance to take motivation into account in the study of achievement in mathematics, the relations between the variables related to students' motivation in this domain remain unclear and deserve further scrutiny.

The present study aims to acquire more specific information concerning the relations between competence beliefs, utility value and achievement goals in mathematics among secondary school students to further document the influence of social agents, and to better understand the relationships between these variables and effort. We also wish to shed more light on the actual debate surrounding the relevance of mastery and performance goals. In sum, the present study has two objectives. First, it intends to test the predictive value of our model of motivation in mathematics. Second, it aims to specify the relationships between the variables of the model in relation to students' age and gender.

Expectancy, values and achievement behaviour

Numerous approaches have been put forth to define motivation and explain its mechanisms. For example, the socio-cognitive paradigm has led to the formulation of many relevant theories. The most important feature of this approach stems from the fact that, contrary to others, it does not aim to define the nature of motivation, but rather explain the student's motivational dynamics in a learning situation (Pintrich & Schunk, 1996). According to socio-cognitivism, cognitions and students' perceptions of their abilities, and their schoolwork act as mediators of their behaviour and explain much of their adaptation to their physical and social environment (Bandura, 1997). The Expectancy-Value theory, inspired by the socio-cognitive approach, has been used in the last few years as a conceptual framework in a number of important studies on academic motivation. In this model, engagement and achievement are best predicted by the combination of students' expectations and value attributed to success (Eccles, Wigfield, & Schiefele, 1998; Pintrich & Schrauben, 1992; Pintrich & Schunk, 1996). The Expectancy component corresponds to students' beliefs about how well they will perform on upcoming tasks and relates to their perception of being able to carry out their academic projects successfully. Expectancy appears to be influenced by task-specific beliefs, such as competence beliefs and personal efficacy expectations (Eccles *et al.*, 1998). The Value component refers to students' interest in the given tasks and subject studied, as well as the utility value, personal goals (Pintrich & Schrauben, 1992) and cost (Eccles & Wigfield, 2002).

Relations among expectancy, value and achievement-related behaviours in mathematics

Research has shown that competence beliefs in mathematics, as well as the value given to this subject, are good predictors of achievement-related behaviours and achievement in this domain (Greene, DeBacker, Ravindran, & Krows, 1999; Singh, Granville, & Dika, 2002). According to Meece, Wigfield, and Eccles (1990), self-perceptions like

competence beliefs have a direct positive effect on value and an indirect positive effect on achievement and achievement behaviours. These results contradict earlier formulations of the Expectancy-Value models which hypothesized that expectancy and value were negatively related, thus arguing that the value of success would be greater when expectations are low and vice versa (Atkinson, 1964). For Eccles *et al.* (1998), value and expectancy are not only positively related, but this relationship is present in both directions. The study of Berndt and Miller (1990) also support the idea of this positive relationship between expectancy and value, as well as the mutual influence of these two variables. They stated that a student who ascribes less importance to success will make less effort and will maintain lower success expectations. For these authors, the opposite also appears to be true. However, Greene *et al.* (1999) add that in high school, mathematics achievement is more closely related to expectations, while value is more related to effort (although results are significant in both cases). Also, most researchers agree that relational patterns between competence beliefs, value, achievement-related behaviours and mathematics achievement seem consistent regardless of the gender (Frenzel, Pekrun, Goetz, & vom Hofe, 2005; Greene *et al.*, 1999; Seegers & Boekaerts, 1996). These results are interesting, in particular, as girls traditionally appear to have lower competence beliefs and ascribe less value to this domain (Chouinard, Vezeau, Bouffard, & Jenkins, 1999; Meece *et al.*, 1990). However, recent findings indicate that girls value mathematics as much as boys do (De Corte & Op't Eynde, 2003; Frenzel *et al.*, 2005; Greene *et al.*, 1999; Mason, 2003; Watt, 2000), which is inconsistent with the findings of the past decade.

Support from social agents and students' achievement behaviour

Other researchers have highlighted the role of social agents, such as parents and teachers in the development of students' self-perceptions and the value they attribute to academic tasks. Several authors have obtained results indicating that adolescents' academic motivation level is influenced greatly by their perceptions of the level of support and encouragement provided by parents and teachers (Eccles & Jacobs, 1986; Grolnick *et al.*, 2002; Grolnick & Ryan, 1989; Wigfield & Eccles, 1992). The aforementioned authors also noted that these perceptions may have a greater impact than achievement in explaining effort, academic and career choices. Researchers have maintained that the attitude of parents and teachers toward mathematics and viewing their children as learners of mathematics affect the children's own perceptions of their competence and values (Singh *et al.*, 2002) and that achievement in mathematics is mediated by teachers' and parents' expectations (Frenzel *et al.*, 2005).

Learner and Kruger (1997) have studied attachment according to a developmental perspective and noted some interesting facts about adolescence. For instance, they have found that representations of the self and others were significantly related to the quality of attachment, and the latter is a relationship developed mainly with teachers, as well as parents. These researchers refer to studies that have demonstrated a positive relationship between teachers' support and a more positive self-concept in relation to school and academic tasks. They concluded, as Eccles and her colleagues do (Eccles, Wigfield, Midgley, Mac Iver, & Feldlaufer, 1993), that the quality of the teacher-student relationship is closely related to students' motivation and attitudes. Studies of Vallerand and his colleagues (Vallerand, Fortier, & Guay, 1997; Vallerand & Reid, 1990; Vallerand & Thill, 1993) also reveal that teachers' behaviour has an indirect influence, either positive or negative, on students' motivation. Thus, the perception of teachers' support acts

upon students' competence beliefs, indirectly affecting their engagement in academic tasks. Some findings in mathematics achievement motivation also indicate that teachers' support is as important as parental support (Chouinard & Karsenti, 2005).

The achievement goals theory and students' achievement behaviour in mathematics

Motivation researchers have also become interested in students' achievement goals and their relation to achievement-related behaviours. The early theories on achievement goals encompass mastery and performance goals. A mastery goal orientation reflects an emphasis on learning and understanding, whereas a performance orientation focuses on demonstrating competence in relation to others (Linnenbrink & Pintrich, 2002). Nonetheless, for several years, some authors have reported that the effect of performance goals differs according to self-perceptions and have proposed an expansion of the theory toward a *multiple goals perspective*. For example, Ames (1992) claims that students who maintain negative competence beliefs as well as high performance goals tend to adopt avoidance behaviours in a learning situation. Furthermore, Bouffard, Boisvert, Vezeau, and Larouche (1995) have shown that mastery and performance goals are not necessarily mutually exclusive. Actually, the desire to reach a high level of achievement is not always incompatible with the pursuit of elevated mastery goals. As a result, most authors distinguish at least three types of achievement goals, which are mastery goals, performance-approach goals and performance-avoidance goals (Harackiewicz, Barron, Pintrich, Elliot, & Trash, 2002; Midgley, Kaplan, & Middleton, 2001; Shim & Ryan, 2005). Students pursuing avoidance goals seek to minimize the negative impact of failure and try to avoid looking incompetent according to comparative standards. For these students, efforts deployed during a task indicate a lack of skills. Therefore, they tend to work as little as possible, appreciating easy success and aiming only to reach a passing grade (Covington, 2000; Linnenbrink & Pintrich, 2002). Alternatively, certain authors suggest that for some students, the ultimate goal is to invest a minimum of effort (Bouffard *et al.*, 1998; Meece & Holt, 1993). Therefore, they propose that these students pursue work-avoidance goals and tend to work as little as possible, appreciating easy success and aiming only to reach a passing grade. Measures of work-avoidance show high reliability and factor analyses indicate that it can be separated from both mastery and performance-approach goal orientations (Skaalvik, 1997).

While some findings indicate that achievement goals, particularly mastery goals, explain significant percentages of achievement variance in mathematics and are strong predictors of effort in that domain (Greene *et al.*, 1999), some authors have raised questions about the degree to which students act on performance goal orientations in their everyday life in school (Brophy, 2005). Also, theoreticians have questioned whether expectancy and value influence achievement goals in mathematics, or whether achievement goals influence expectancy and value. Some findings support the hypothesis that mastery goals influence competence beliefs in mathematics (Middleton, Kaplan, & Midgley, 2004), while others support that competence beliefs predict achievement goals (Greene *et al.*, 1999).

Current study

While many studies have focused on age and gender differences in mathematics motivation, we have only a limited understanding of the transformations undergone by the variables involved in motivation during adolescence (Heller & Ziegler, 1996; Wolters

& Pintrich, 1998). Among others, Singh *et al.* (2002), argue that relationships between attitudes, motivation and achievement-related behaviours in mathematics are insufficiently documented and require further investigation. Moreover, the influence of social agents deserves further scrutiny.

In the present study, a model comprising the perception of support from social agents, competence beliefs, utility value and achievement goals was used to explore high school students' effort in mathematics. An overview of the model is shown in Figure 1. One major feature of the model is the inclusion of task-specific achievement goals as a direct influence on effort. This modification was suggested by Greene *et al.* (1999) who demonstrated that task-specific goals act as mediators between beliefs, values and achievement-related behaviours in mathematics, and there are theoretical and methodological reasons for competence beliefs and value to precede achievement goals in conceptual models when goals are operationalized in terms of a specific setting and not in terms of trait-like characteristics. As stated previously, the present study has two objectives: to test the predictive value of our model of motivation in mathematics (depicted in Figure 1) and to specify the relationships between the variables of the model in relation to students' age and gender.

Method

Participants

The sample used in the present study was initially composed of 759 French-speaking participants (389 males and 370 females; mean age = 15.08, *SD* = 1.69) from four public high schools in the Montréal region (Canada). The participants were registered in 'regular' compulsory mathematics courses offered in Grades 7 through 11. Students in remedial and special classes were not included in the study. All subjects were aged between 12 and 18.

Measures

The theoretical model proposed earlier takes into account a number of variables which can be classified into five distinct categories. The first category is related to the perception of social agents' support and includes students' perception of the encouragements provided by parents and teachers. The second represents students'

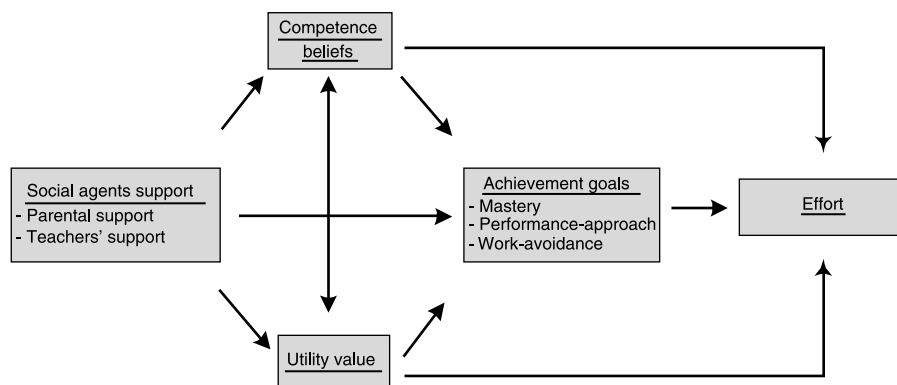


Figure 1. Anticipated direct and indirect relations among variables in the theoretical model.

self-perceptions in mathematics and involves students' competence beliefs. The third one focuses on the students' values and includes math-perceived utility goals. The fourth category comprises achievement goals (mastery, performance-approach and work-avoidance). Finally, effort constitutes the dependent variable in the model. Several scales from different sources were used to assess these variables. As presented below, all these scales demonstrate satisfactory levels of reliability and consistency. Items were rated by the participants on a 5-point Likert-type scale, ranging from 1 ('Strongly disagree') to 5 ('Strongly agree').

The perception of support from social agents was measured with scales from an abridged version of the Fennema and Sherman Mathematics Attitude Scales (1976), translated into French and validated by Vezeau, Chouinard, Bouffard, and Couture (1998). The Parental Attitude Scale ($\alpha = .80$) comprises four items. This scale measures students' perception of the level of parental support, as well as the perceived confidence expressed with regard to their child's ability to succeed in this subject (e.g. 'My mother has always been interested in my progress in math'). The four items in the Teachers' Attitude Scale ($\alpha = .76$) measure students' perception of their mathematics teachers' support and the confidence they express in students' ability to succeed ('My teachers think that I am the kind of person who can be very good at math').

The Confidence Scale, also from the Fennema and Sherman's Mathematics Attitude Scales (1976), was used to measure participants' competence beliefs ($\alpha = .83$) ('I am certain I can succeed in mathematics'). This scale includes six items.

Perceived mathematics utility was also measured using a scale from the French version of the Fennema and Sherman's Mathematics Attitude Scales (1976). This scale implies five items ($\alpha = .82$) which measure the participants' perceptions of the present and the future usefulness of mathematics (e.g. 'What I learn in math will be useful during my adult life').

Achievement goals were assessed by an instrument developed and validated by Bouffard *et al.* (1998), consisting of three subscales. The Mastery Goals Subscale ($\alpha = .91$) entailed eight statements assessing the extent to which participants wished to master the content of their mathematics courses (e.g. 'In mathematics, I like difficult activities that allow me to acquire new knowledge'). The Performance-approach Goals Subscale ($\alpha = .74$) consisted of six statements which measure the degree to which participants set personal goals about being among the best in their class and obtaining high marks in mathematics (e.g. 'In mathematics, I compete with others to get the highest marks'). The Work-avoidance Goals Subscale ($\alpha = .78$) entailed six statements which measure the degree to which participants set their goals in terms of doing the least possible work (e.g. 'In mathematics, I aim only at the passing grades').

Finally, three items were produced to measure participants' perception of the level of effort they put in the learning of mathematics ($\alpha = .87$; e.g. 'I work hard in mathematics', 'When I do mathematics tasks, I work very hard'). The resulting questionnaire was administered at the end of the school year (late May) and was completed during students' mathematics class.

Results

To assess the coherence and independence of the scales, we first performed an exploratory factor analysis (principal axis factoring with Oblimin rotation with Kaiser normalization). This process was conducted on the full sample with SPSS 13 for

Windows. Eight factors were extracted with eigen values ranging from 0.97 to 11.54. These eight factors represent all the scales used in the study but several items had to be removed because they cross-loaded on two factors with values higher than 0.4. These items were chiefly related to performance-approach, work-avoidance and competence beliefs. The final results indicate good internal validity of the measures. We then performed a confirmatory factor analysis using LISREL 8.72, which confirmed the structure of the data and its goodness-of-fit (RMSEA = .059). The resulting standardized factor loadings and standard error indices are shown in Figure 2.

Secondly, we examined males' and females' correlations between the participants' age and the other variables. As can be seen in Table 1, these analyses indicate that all the variables in the structural model equation are correlated. Also, these correlations present similar results for both genders. Moreover, many significant correlations between age and the other variables are observed, indicating that older participants are less motivated than younger ones.

We then estimated the model, a mixed structural equation model with latent endogenous variables and an observed exogenous variable (age), in several steps, using LISREL 8.72 computer programme (Jöreskog & Sörbom, 1993). As recommended by Hoyle (1995) and Hu and Bentler (1999), the goodness-of-fit of these models was assessed using chi-squared and several other indices of fit such as the root mean square error of approximation (RMSEA), the incremental fit index (IFI) and the Bentler-Bonett non-normed fit index (NNFI). A good fit of a specified model to the data is generally indicated when the χ^2/df ratio is less than 3. However, this measure appears less reliable in the case of large samples (Ntoumanis, 2001). By convention, there is also good model

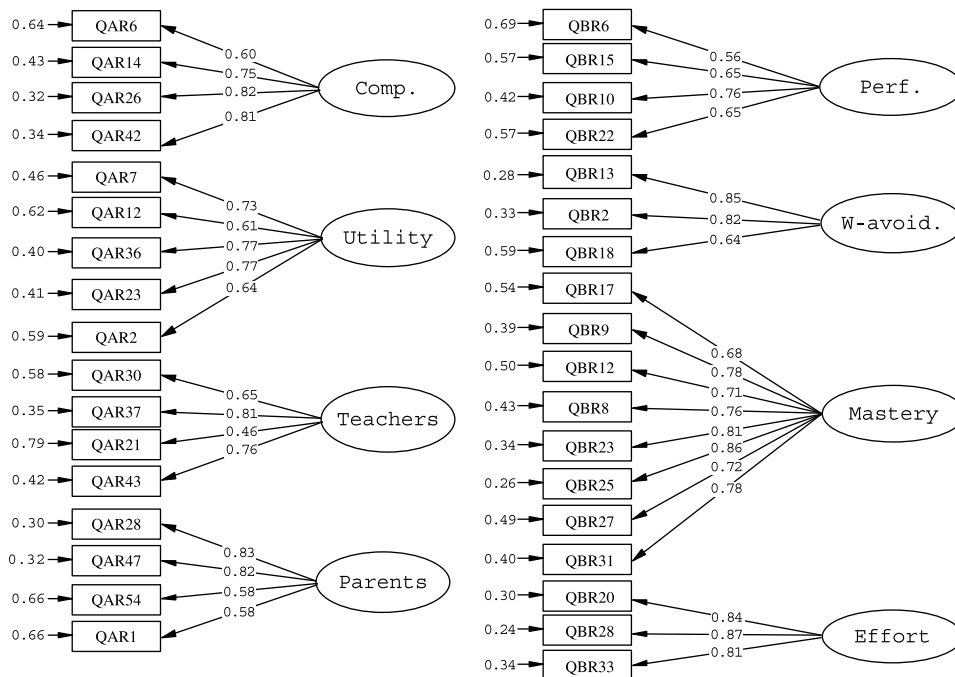


Figure 2. Items factor loadings and standard error indices from the confirmatory factor analysis (whole sample – maximum likelihood).

Table 1. Pearson's correlation coefficients between variables (males and females)

Variable	Females									Males
	1	2	3	4	5	6	7	8	9	
1. Age (months)	1	-.160**	-.037	-.125*	-.285**	-.083	.082	.144*	-.158**	
2. Parental support	-.293**	1	.346**	.163**	.405**	.379**	.197**	-.240**	.336**	
3. Teachers' support	-.130*	.404**	1	.257**	.291**	.421**	.142*	-.287**	.467**	
4. Competence beliefs	-.101	.229**	.328**	1	.391**	.469**	.342**	-.547**	.517**	
5. Utility value	-.298**	.427**	.288**	.444**	1	.566**	.303**	-.438**	.458**	
6. Mastery goals	-.113*	.447**	.442**	.473**	.594**	1	.363**	-.577**	.675**	
7. Performance-approach	.066	.165**	.321**	.358**	.271**	.472**	1	-.413**	.230**	
8. Work-avoidance	.136*	-.297**	-.406**	-.431**	-.360**	-.567**	-.398**	1	-.504**	
9. Effort	-.139*	.449**	.434**	.517**	.546**	.656**	.325**	-.396**	1	

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

fit if RMSEA is less than or equal to .05. There is adequate fit if RMSEA is less than or equal to .08. More recently, Hu and Bentler have suggested $RMSEA \leq .06$ as the norm for a good model fit. RMSEA is a popular measure of fit, partly because it does not require comparison with a null model and hence does not require that the researcher posits a plausible model in which there is complete independence of the latent variables as does, for instance, CFI (Hoyle, 1995). By convention, IFI should be equal to or greater than .90 to accept the model. NNFI close to 1 indicates a good fit. Hu and Bentler (1999) have suggested $NNFI \geq .95$ as the norm for a good model fit.

In order to test gender differences, we then performed a multi-sample analysis. To do so, the models were tested in a single analysis, with varying degrees of constraints applied to each of its paths. As seen in Table 2, imposing the equality constraint on the measurement weights did not significantly reduce the fit of the model in terms of the Likelihood Ratio test, χ^2/df ratio and RMSEA. Therefore, the more constrained models could be considered to have a similar fit as the baseline model. Overall, these results strongly suggest equality of structural relations across both genders. Consequently, it can be concluded that the structural weights for relations between the variables retained could be considered equal for males and females. Gender may be a significant predictor of mean level differences of mathematics-related variables, but not of the structural relationship between variables. Consequently, we decided to pool data from male and female subjects in order to include gender as a predictor in the central model.

Table 2. Gender-based invariance tests

Model	χ^2	<i>df</i>	$\Delta\chi^2$	Δdf	χ^2/df	RMSEA	<i>p</i>
Baseline	2052.30	764			2.68	.068	
Utility → effort	2050.59	763	1.71	1	2.69	.068	<i>ns</i>
+ teachers' support → utility value	2049.99	762	2.31	2	2.69	.068	<i>ns</i>
+ age → competence beliefs	2047.95	761	4.35	3	2.69	.068	<i>ns</i>
+ age → teachers' support	2046.83	760	5.47	4	2.69	.068	<i>ns</i>

The base model including gender, age, competence beliefs, utility value, mastery goals, performance-approach goals and work-avoidance as predictors, and effort as the outcome variable was then computed. Missing data (about 10%) were handled with an imputation, using the EM algorithm from LISREL. Overall, the fit of this model was reasonably good, as is shown by the diverse fit indices ($\chi^2 = 2835.30$, $df = 592$, $RMSEA = .061$, $NNFI = .96$, $IFI = .96$, $CFI = .96$). For reasons of parsimony, we then decided to eliminate work-avoidance goals because this variable had no significant direct or indirect relations with effort, the outcome variable. This resulted in a goodness-of-fit similar to the previous model ($\chi^2 = 2450$, $df = 500$, $RMSEA = .062$, $NNFI = .97$, $IFI = .97$, $CFI = .97$). For the purpose of clarity, these various fit indices are given in Table 3. Considering the equivalence of the two models in terms of goodness-of-fit and for reasons of simplicity, we decided to retain the revised model as the final. Figure 3 displays the significant structural weights when estimated freely with standardized maximum-likelihood parameter. The arrows indicate statistically significant relationship between variables ($Z > 1.96$).

Table 3. Indices of fit for base and final structural models

Model	χ^2	df	χ^2/df	RMSEA	NNFI	IFI	CFI
Base model	2835.30	592	4.789	.061	.96	.96	.96
Final model	2450.00	500	4.900	.062	.96	.97	.97

Because the fit indices indicate a theoretically sound model that explained the data well, we interpreted the structural relationship in the model as the effect of one variable on the other. Moreover, the direct and the indirect effects on effort in mathematics were also examined (see Table 4). The four direct effects on effort in mathematics were mastery goals, competence beliefs, gender and performance-approach. The strongest direct effect was mastery goals ($\beta = 0.61$). The strongest total effects were mastery goals ($\beta = 0.61$) and competence beliefs ($\beta = 0.52$). Perception of the support from teachers ($\beta = 0.32$) and parents ($\beta = 0.29$), as well as utility value ($\beta = 0.25$) exerted moderate total effects. Gender ($\beta = 0.13$), performance-approach ($\beta = -0.11$) and age ($\beta = -0.01$) effects were small. Interestingly, analyses also revealed that the effects of students' perception of support from social agents were mediated differently. While parental support appears to affect mainly utility ($\beta = 0.39$), teachers' support usually affects competence beliefs ($\beta = 0.29$) and mastery goals ($\beta = 0.25$). Gender had a significant positive effect on the outcome variable and on mastery goals. This indicates that females reported higher effort and mastery goals. A negative effect on competence beliefs appears to indicate that female subjects report lower self-evaluation of their ability in mathematics than male subjects. Finally, age had significant negative effects on most endogenous variables. These last results reflect that older participants had lower perception of social support, as well as lower competence beliefs, utility value and mastery goals than younger participants.

Discussion

The purpose of the present study was to acquire more specific information concerning the relations between competence beliefs, utility value and achievement goals in

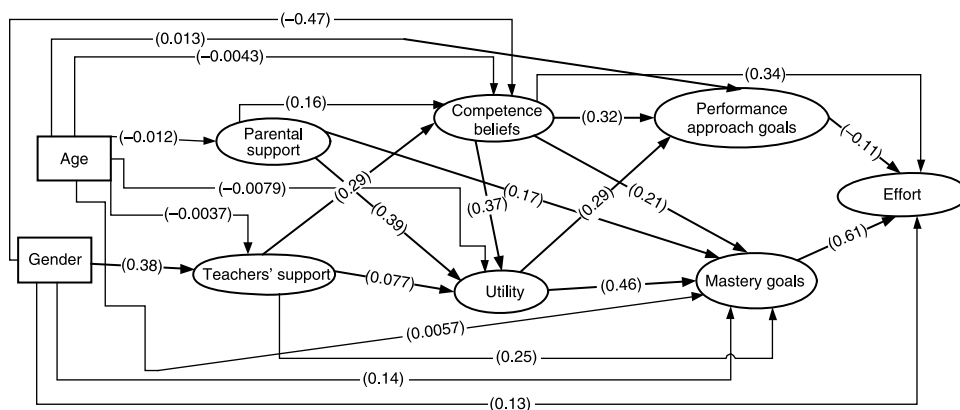


Figure 3. Final structural equation model (males = 0, females = 1).

mathematics among secondary school students, to further document the influence of social agents, and to better understand the relationships between these variables, as well as to effort. As far as the initial objectives are concerned, results of the present study confirm the usefulness of our model in order to explain the variance in measures of students' effort in mathematics. Moreover, our results support theoreticians who have proposed that achievement goals mediate expectancy and values and those who operationalized achievement goals in terms of a specific setting instead of trait-like characteristics. Furthermore, our results highlight the relationships between competence beliefs, utility value and achievement goals but also emphasize the positive and complementary nature of those relationships. Thus, students will have a tendency to ascribe greater utility and mastery goals to activities in which they feel competent and make more effort to succeed in those activities. In the same manner, students who have lower competence beliefs will ascribe less importance for success, follow lower achievement goals and make less of an effort to succeed (Berndt & Miller, 1990).

Competence beliefs, utility value, achievement goals and effort in mathematics

Many researchers have indicated that competence beliefs in mathematics, as well as the value given to this subject, are good predictors of achievement-related behaviours (Greene *et al.*, 1999; Meece *et al.*, 1990; Singh *et al.*, 2002). According to their results, self-perceptions have a direct positive effect on value and an indirect positive effect on engagement. The results obtained in the present study partially confirm these findings and indicate that competence beliefs directly predict effort and this variable's effects are also mediated by mastery goals. Competence beliefs exerted a total effect on the outcome variable nearly as great as mastery goals. Therefore, it appears that competence beliefs exert an important effect on effort in mathematics. This result is not consistent with those of other researchers, who claimed that, in high school, engagement is more closely related to value than to success expectations (Berndt & Miller, 1990; Greene *et al.*, 1999; Shapiro, 1993; Stipek, 1993).

The findings of the present study also confirm that the level of mastery goals is the strongest predictor of high school students' effort in mathematics, regardless of age or gender. However, it is interesting to observe that in our study work-avoidance goals did not exert any direct or indirect effect on effort. Furthermore, performance-approach goals were marginally and negatively related to effort. The fact that performance-approach goals were negatively related to effort may appear surprising, in particular while Pearson correlations between these variables were significant and positive (see Table 1). However, we should highlight again that it was not the level of effort of students that was taken into account, but rather their perception of the level of effort they put in the learning of mathematics. It is therefore possible that participants pursuing performance goals believed their efforts insufficient. Nevertheless, it appears that our findings indicate that one's perceived level of effort is not necessarily influenced by the desire to avoid working hard or to compete with others to get the best results or the highest marks.

The role of social agents

Results obtained in the present study also confirm the role of social agents in the students' motivational process. Many researchers have outlined that adolescents'

attitudes toward mathematics and their decision to pursue their involvement in this subject are greatly influenced by parents' attitudes toward this subject, as well as parental perception of the level of difficulty that it represents for their child (Grolnick *et al.*, 2002; Grolnick & Ryan, 1989; Wigfield & Eccles, 1992). According to these authors, such factors play a greater role than performance in explaining academic and professional aspirations related to mathematics. Our results demonstrated an indirect effect between the perception of social agents' support and effort, acting mostly on competence beliefs, utility value and mastery goals, which serve as mediating variables. Moreover, our analyses lead us to believe that in adolescence, for mathematics at least, teachers may have a role equal to that of parents concerning students' self-perceptions, values, achievement goals and effort. Indeed, our results demonstrate that utility value is mostly predicted by the perception of parental support while competence beliefs are mostly predicted by teachers' support and mastery goals are best predicted by both social agents. In other words, parents exert a strong influence on their children's values regarding mathematics while the nature of teachers' influence also exerts its impact on students' self-perceptions. Other authors have indicated that support from teachers is directly associated with students' self-perceptions (Eccles *et al.*, 1993) and performance in mathematics (Adams & Singh, 1998). This could be explained by the fact that teachers are the first judges of students' skills and they constantly reflect back judgments on their competence.

Differences across genders

Several researchers have argued that success expectation predicts engagement for girls while values and goals have this function for males (Berndt & Miller, 1990; Eccles, 1994). In other words, females' motivation in mathematics appears to be more related to how they evaluate themselves in this domain while the perceived usefulness of mathematics exerts more effect on males' motivation and behaviour. Our own results do not reproduce these findings.

Indeed, our results demonstrated that females report lower competence beliefs in mathematics than males, but they also indicated that females report higher mastery goals and effort. Moreover, no significant relationship was found between gender and utility value. This last finding is contrary to the literature of the past decades, but in accordance with recent studies which highlight that girls, nowadays, value mathematics as much as boys do (De Corte & Op't Eynde, 2003; Frenzel *et al.*, 2005; Greene *et al.*, 1999, Mason, 2003; Watt, 2000). Nevertheless, it can be inferred from the present study that the pattern of relationships between social support, competence beliefs, utility value and achievement goals in mathematics is very similar for males and females. The test of invariance between the latent variable structures for both genders confirmed this hypothesis which is in line with other researchers' findings (Frenzel *et al.*, 2005; Greene *et al.*, 1999; Seegers & Boekaerts, 1996). Thus, in our study, the main role of gender was through its mean-level effects and not through the nature or the strength of the relations between the variables retained. These results are contrary to the claim of some who want to create a crisis about boys' education, but in line with the gender similarities hypothesis (Hyde, 2005) which holds that males and females are alike on most psychological factors.

The main conclusions stemming from the present study is that the nature and the strength of the relationships between competence beliefs, utility value, achievement goals and effort are not significantly influenced by age and gender, at least in the learning

of mathematics in school context. Moreover, our results indicate that achievement-related behaviours are not significantly related to the desire to avoid working hard and that they are feebly influenced by the goal to being superior to others. In other words, they suggest that social comparisons exert less influence on engagement in academic tasks than the aspiration to understand and to learn academic content. Therefore, our results lead us to think that the need of distinguishing four types of achievement goals, as is done in recent literature, may be supererogatory in the case of engagement and effort in academic tasks.

On the basis of our results and as underlined by many (e.g. Ames, 1992; Brophy, 2005), teachers should avoid eliciting competition among their students and foster competence beliefs, utility value and mastery goals instead. To this effect, specialists have emphasized that certain teaching practices tend to help convey high expectations to students: presenting tasks as realistic challenges, increasing help rather than diminishing the relative difficulty of tasks, questioning in a stimulating way, teaching efficient learning strategies and promoting strategic effort (Ames, 1992; Good & Brophy, 1995). Other teaching practices are known to exert positive effects on the goals and the value students attribute to tasks and school subjects: making sure students are well aware of the content to be learned and the competence to develop, making them understand the meaning of what is learned, proposing stimulating tasks, offering options in content and strategies, and helping students establish goals for themselves (Ames, 1992; Archambault & Chouinard, 2003; Good & Brophy, 1995; Karsenti, 1999).

The first limitation of our study resides in the fact that comparisons by age and gender were completed employing cross-sectional analysis. It would be useful to pursue the same objectives in a longitudinal research study by repeatedly measuring a sample of students of both genders and taking a number of school subjects into account. According to us, such an approach would further help understanding the mechanisms involved in academic motivation and the evolution of these mechanisms in adolescence. Second, the exclusion of students in remedial and special classes leaves us with no information on the impact of self-perceptions, values and goals in that special population. A similar study with that population of students could also prove interesting. Furthermore, the self-reported nature of the data and the fact that effort was not objectively measured is another limitation, therefore highlighting the need for more objective and empirical data.

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