NEW PERSPECTIVE ON STUDENTS' MOTIVATION TO LEARN MATHEMATICS

Daniela CĂPRIOARĂ,
Associates Professor, Ph.D,
Ovidius University of Constanta

Abstract: School work emphasizes the most the dynamic and complex nature of motivation. Among the conditions and internal mechanisms of teaching and learning mathematics in school, motivation occupies a privileged position due to the influence it has on the behavior of students and teachers during the process. Epistemological and motivational beliefs of the student are important factors in learning mathematics. From the interaction between the student and the teacher, the particularities of the didactic activities, the classroom climate and the mathematical curriculum results student's motivational state. Each of these factors of motivational dynamics can generate obstacles of motivational nature which middle school students face in learning mathematics. Students' perceptions and beliefs of school mathematics influence their level of motivation and thus the school success.

Keywords: motivational factors, mathematics learning,obstacles

Theoretical framework

Learning mathematics in school is a complex process that harnesses the motivational potential of all the factors involved in its implementation. Energy resources of the human factor (teachers and students) are the ones that set in motion and support the learning process, aspect that emerges from the definitions of motivation found in specialty literature. One of the latest definitions, mentioned by Middleton (2014, p. 17), presents motivation as „the deeper energy that exist in each learner and has a direction or goal, even if that goal is not aligned with the current classroom goal or is not apparent to the teacher".

From a sociocognitive perspective, the study of motivation involves understanding the influence motivational beliefs exert on actions/behaviors allegedly necessary for learning in a given environment, taking into account the emotions that may or may not interfere, in one way or another, upon the beliefs.

(Crahay & Dutrévis, 2010, p.37). The reference object reflected in the motivational beliefs is different (see Crahay & Dutrévis, *source cit*., pp. 38-39): task's value (pattern of Eccles&Wigfield, 2002), sense of competence (patterns of Bandura, 2003; Dweck, 1999), goal orientation (patterns of Dweck &Leggett, 1988; Elliott&Dweck, 1988). In this latter model, the orientation of goals, together with the perception of own competence and the conception on intelligence, represent the variables from whose interaction result behavioral profiles *helpless* type *(resignation profile)* and *mastery-oriented* type *(involvement in knowledge profile)*.

Learning mathematics exploits all individual resources (beliefs and behaviors) of the student: *a positive sense of self-efficacy; the belief that success follows proper effort; interest that is enduring rather than situational; goals for the exploration and developing competence; value for the activity and its usefulness; a sense of connection with others*. Some of these individual qualities mentioned by Middleton (2014), constituting determinants of motivation, can be found in the most appropriate motivation patterns for learning mathematics in school. Thus, the model developed by Eccles & Wigfield (apud Middleton, 2014) starts from theory expectation-value: „an individual shall not engage in any activity unless he perceives its utility, giving its value, the anticipated outcome being important for him and the cost/effort submitted not being exorbitant." Consequently, the value (in terms of importance and utility) that students assign to school achievement, or to school generally, is essential for learning school mathematics. Research shows that students do have conscience, but they do not always have the belief of the utility of mathematical knowledge learned in school (Căprioară, 2011). In this matter, children are directly influenced by adults and, in particular, by their parents and teachers, being generally sensitive to the message they send with refference to the link between academic success and professional success (perceived utility).

Keeping the same frame of reference, Viau (1999) built a model of motivation in school context, from the definition of motivation, inspired by the work of researchers with a focus on sociocognitive educational phenomenon (Schunk, Zimmerman, Pintrich and Schrauben). Thus, in the academic context, motivation is „a *dynamic state* which has its origins in *perceptions* that a student has *on himself* and about *the environment* and which stimulate *his choice* of an activity, his *engaging* and his *persevering* in its achievement in order to *reach a goal*." (Viau, 1999, p. 7.).

Based on this definition, the author has developed a model of motivation for school work, shown below:

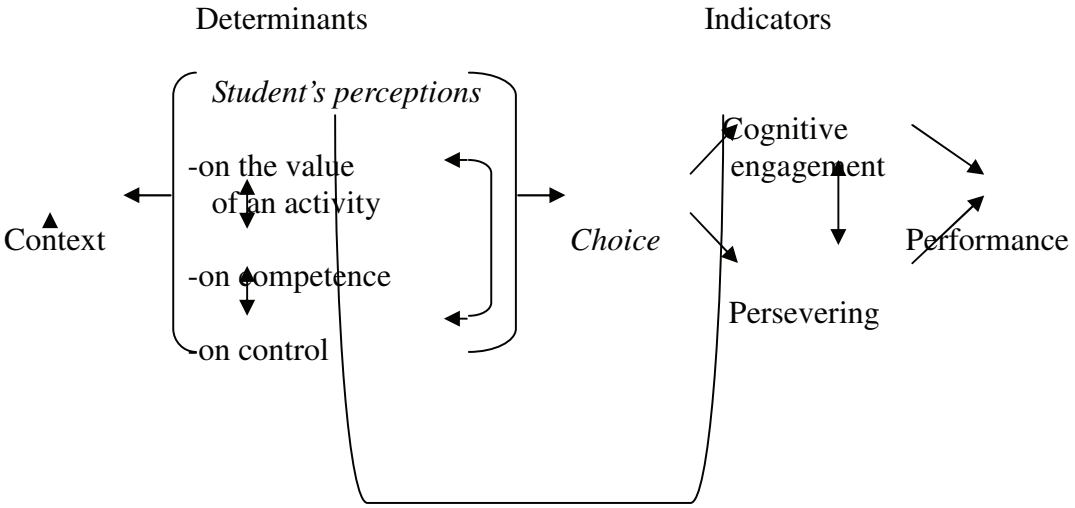

Figure 1. Motivation model in school context (after R. Viau, 1999, p. 32)

According to this model, motivation for learning mathematics follows the dynamic of the bifactorial relationship determinants-indicators, mediated by the emotions experienced by students in the learning process. The way in which students perceive didactic situations created by the teacher (a positive sense of self-efficacy and value for the activity and its usefulness, aspects which are built based on school experiences and in which the mathematics teacher plays a crucial role) plays a decisive role on their level of engagement in the learning activities. The model suggested by Viau mentions the engagement in solving the task and the perseverance in overcoming difficulties as indicators of motivations. Student's behaviors, markers of engagement in the mathematics learning process are of strong interest for the activities suggested by the teacher and towards mathematics, effort, ready to participate fully in the classroom, eager to relate to the mathematics teacher.

Another factor with significant impact on the level of motivation of students for learning mathematics is the *classroom climate*, determining students' emotional feelings. Sousa (2017, p.50) states that „students need to feel safe in terms of physical and emotional security before they cand focus on the curriculum." The way in which the math teacher manages the errors students make in the learning process, as a result of confronting themselves with a specific obstacle (Căprioară, 2011), influences their motivational state for learning mathematics, from joy and excitement to total denial and even abandon. Students motivation for learning mathematics is also strongly influenced by the way in which they relate to mathematics-school subject, which often puts students in difficulty and therefore the need of support from the teacher is higher. The motivation for learning mathematics is present when the teacher is closer to the students („stay on them")

and understands them and is willing to provide additional support, teaches clearly and tidily.

Thus, the teacher can, and even should ensure a positive climate, generating stenic emotions necessary to achieve the learning objectives aimed and, in this matter, the same author (Sousa, 2017, p. 135) suggests two action levers, accessible for the mathematics teacher: 1) Ensuring a positive climate through: promoting a positive relationship between students, so that they are nice to each other, they listen to each other and respect different points of view; cultivating a positive relationship with all students, so that they feel that the teacher is not only concerned with academic success, but also with the student as an individual; developing and strengthening the rules of the classroom, which should be simple, clear and should ensure a physically and emotionally secure learning environment. 2) Questioning students individually, from time to time, in order to find out whether they feel safe in the classroom, if they are nice to each other, if they feel welcomed and included in the class. Using students' feedback in order to make any necessary adjustments to improve the climate.

Each classroom has its own motivational which is built from students' experiences, such as their perceptions of themselves, their academic work, and their social interactions. „The instructional and psychological environments of classroom have been consistently related to the motivation reported by individual students" (Meece, Anderman &Anderman, apud Middleton, 2014). The motivational quality of classroom may be thought of acronym TARGET (based on the work of Epstein and Ames, apud Middleton, 2014, p. 30): Task, Autonomy, Recognition, Grouping, Evaluation and Time, to which has been subsequently added the cathegory of „social" features of the classroom. Each of these represent vectors of motivation for learning, while math classes fully argue each of these dimensions.

Research and practice show that *teacher characteristics* are some of the essential factors that influence the classroom climate. In order to motivate students, the math teacher should show optimism and enthusiasm, open-mindedness; fair-play; confidence; tolerance for ambiguity, perseverence, interest and passion for mathematics, qualities that are transferred in a greater or a lesser extent to the students. „Teacher's dispositions directly contribute to the sense of the classroom as a safe place to work, make mistakes, and take risks, which are important elements of motivated behavior. A classroom in which students feel a sense of belonging, personal support, and support for learning rather than focusing on conflicting motivation. Meeting the psychological needs of students through creating predictable, positive, and emotionally and personally supportive environments provides an *area of confort* (Simmons & Blythe, 1987) or a stage-envoronment fit (Eccles & Midgley, 1989) that is the basis for meaningful engagement" (Middleton, 2014, p.36). This area of confort in the classroom is very important for mathematics learning.

As previously shown, in the combinatorics of the determinants of school motivation, emotions play an increasingly more central role, as proved by research (Bouffard & Vezeau in Crahay & Dutrévis, 2010, p. 38). The feedback received after a learning sequence determines the way of representation of the task, affecting student motivational beliefs. From this point of view, „the teacher has a crucial role to play. Through advice, encouragement, corrective subtle feedbacks when the student makes a mistake, he can help the student activate its most positive motivational beliefs (the importance and usefulness of task, the sense of competence, the goal orientation). Conversely, it may cause the student to doubt, to strengthen fears, to move towards performance rather than understanding and even to lead to discouragement and resignation." (Crahay & Dutrévis, 2010, p. 42)

Other factors that influence the motivational qualities of the mathematics class are the *instructional practices*, which, together with the *mathematical curriculum* may contribute to the support or, conversely, to the blocking of the mathematics learning process. The forms of class organization (whole group, small group or individual), the ways of approaching the teaching (centered on the teacher, on the content, or on student's needs; teacher-source of information or teacher more as a facilitator for the learner to construct understanding), the rules and regulation that guide classroom behavior (authoritarian style or democratic style) are just some of the instructional practices used in math classes. In Middleton's opinion (2014), *curriculum* defines the larger structure of what happens in the classroom and may be considered as more or less motivating for students. Different types of curricula influence differently students' motivation to learn, in general: Inquiry-Based Curricula (may relate to engagement through the opened nature of tasks, potential to work with students and the accountability of presenting findings); applied curricula (engage students by relating content to real-world problems or everyday life); thematic curricula (activate motivation by increasing task value). This aspects invite mathematical curriculum designers to reflection.

The incursion, even briefly, in the field of motivation for learning school mathematics proves the complexity of this learning factor-condition. As Middleton (*source cit*, p. 38) also states, „none of the individual and classroom factors described early guarantee motivation by itself, but it is the combination of particular student qualities within facilitative classroom working". Therefore, the responsability lies with all factors involved in the learning process, but the teacher plays the key role. Motivation for learning mathematics requires additional attention and reflection.

Methodology

The research is part of a larger study on *obstacles and errors in learning mathematics at middle school level* (Căprioară, 2011). One of the variables of the research was the students' motivation to study mathematics in secondary school, in order to identify *motivational obstacles*, such as *the affective-emotional state and*

middle school student's self-esteem in relation to mathematics and its conceptions (favorable or unfavorable attitudes and prejudices) about mathematics-school subject, which affect the training process.

Research data was recorded based on a *opinion survey omnibus type* applied on a number of 350 students from the 8th Grade (ending middle school studies), the equivalent of 22 classes of students from 19 areas (12 rural and 7 urban) and included 4 Counties from south-eastern Romania. The reason for choosing 8th graders is twofold: the experience accumulated in relation to school mathematics (at least 8 years of study), respectively the possibility of formulating and expressing opinions on mathematical training, due to the maturity level reached and the perspective on the education system. Information drawn from respondents' answers was completed by the conclusions drawn from two focus-groups in which took part teachers with extensive teaching experience. Information interpretation was nuanced by personal experience as a mathematics teacher.

The research methods included also *a focus-group* organized with *teachers.*

Results and discussions

Teachers' opinions about middle school student motivation for learning mathematics took the shape of a few conclusions:

- There are many children with high Iqs but have poor results in mathematics because they are not interested in this subject. It is quite common among students to say „I do not like math."
- Time resources available to the teacher to cover the mathematics curriculum (4 hours/week for arithmetics, algebra and geometry) are not sufficient to introduce, set and apply the knowledge. Time pressure acts in a destructive way on the process of building mathematical concepts. On the other hand, students often have a work schedule (5-6 hours at school plus 3-4 hours for home study) which exceeds the 8 hours/day schedule of an adult. This can lead to overloading the students which triggers a feedback of refusal when it comes to learning.
- Learning mathematics in middle school is not focused on building concepts; it it generally a mechanical learning of some types of problems (for which, most of the time, the utility is „not seen") and of solving algorithms, „without reaching the core of things".
- General attitude towards work, manifested to a greater extent (social context), issue that affects negatively students' attitude on school in general.

Students' opinions, recorded on the base of the survey, expressed *their perception on their own competences* regarding the learning of mathematics, as well as *the perception of their ability to control their own learning process.*

The first set of items aimed at students' beliefs on the learning of mathematics:

I believe that:

I 1: *any student can learn mathematics;*

I 2: *learning mathematics requires a lot of effort;*

I 3: *you must be „gifted from nature" in order to be good in mathematics;*
I 4: *the talent in mathematics is inherited from parents.*

By applying *Wilcoxon Signed Ranks Test* for this first set of items results the following hierarchy between these beliefs.

I believe that:

- *learning mathematics requires a lot of effort*
- *any student can learn mathematics*
- you must be „gifted from nature" in order to be good in mathematics
- the talent in mathematics is inherited from parents

Distribution rates for the first two items (Table 1) show that a very large proportion of students consider rather that *every student can learn mathematics* (more than 80%), but also that *a lot of effort is required in order to learn mathematics* (over 84%), which shapes a positive outlook on their opportunities to learn mathematics and, at the same time, an accountability regarding the level of mathematical knowledge gained, especially considering the effort put in this regard. These beliefs show that any possible failures in learning mathematics have *internal and controllable causes*, on which students can act. Such consciousness has positive effects on student motivation for learning mathematics, but goals aim more to performance than to learning (Căprioară, 2011).

Tabel 1. Distribution rates for items I 1 and I 2

Item	Totally disagree with the state ment	Disagree with the state ment	Partially disagree with the state ment	Partially agree with the state ment	Agree with the state ment	Totally agree with the state ment
I 1: *I believe that any student can learn mathematics*	3,44%	5,44%	10,89%	21,49%	20,34%	38,4%
I 2: *I believe that learning mathematics requires a lot of effort*	2,87%	3,44%	8,88%	15,76%	26,93%	42,12%

A measurement of motivation is *the level of involvement of students in solving specific tasks* of maths learning. Concerning this, the following item was built:

I 5: *I get involved in solving tasks (questions, problems, ...) the teacher assignes in class.*

Over 75% of the students surveyed say that they commit to solve learning tasks when under teacher observation (in the classroom), and almost half of them assume their duties largely or in a very great extent. It remains, however, a significant percentage of students who would rather circumvent these activities, even during math classes, as shown in the diagram below:

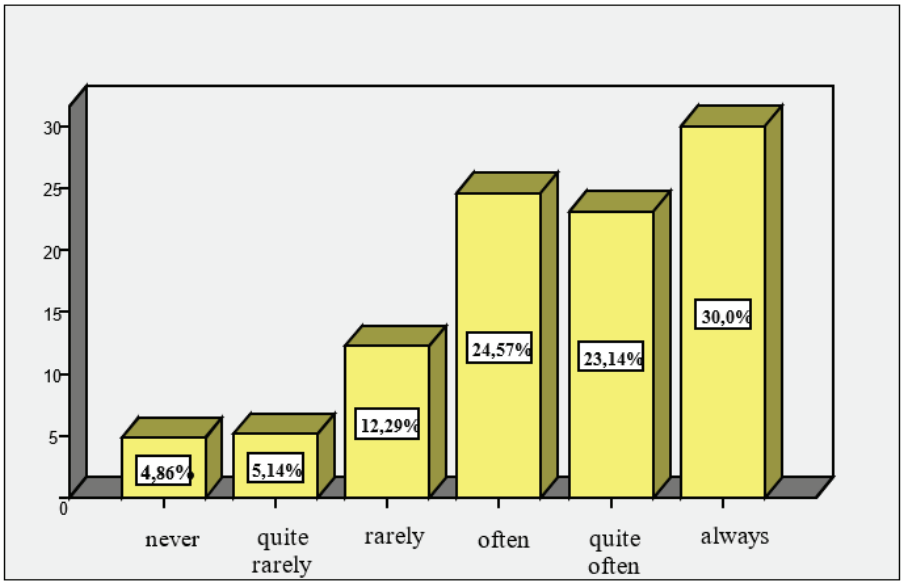

Figure 2. Frequency distribution on student involvement in solving tasks in class

Self-confidence is a determinant, but also an indicator of the level of motivation:

I 6: *I consider myself able to cope with the requirements from math classes,*

Looking at the diagram in Figure 3, we see that 75% of the eighth graders enrolled in the research are considered rather able to cope with specific requirements from the math class, which proves a high level of confidence in their own abilities. For students, this is an important foothold regarding the taking of school-type responsabilities.

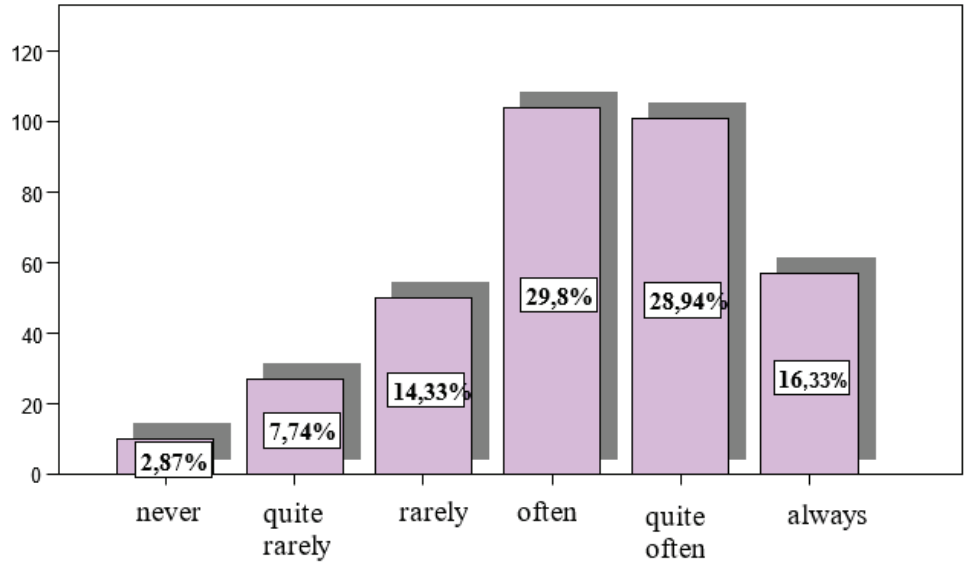

Figure 3. Frequency distribution on „students' perceptions of their own abilities to learn mathematics"

This positive perception of students on their abilities to learn mathematics is closely linked to results achieved by them in previous middle school grades (ρ = .562, p<.01), as shown below:

Table 2. Link between „students' perceptions on their own abilities to learn mathematics" and „results in mathematics"

Spearman's rho		***I consider myself able to cope with the requirements from math classes***
average score in maths in middle school (grades 5th-7th)	**Correlation Coefficient**	**,562(**)**
	Sig. (2-tailed)	**,000**
	N	**350**

** Correlation is significant at the 0.01 level (2-tailed).

Another item, that verifies the same perceptions, but from a different point of view is the following:

I 7: *Mathematics is a subject to which I pay a special attention in my school training.*

The most answers (26,29%) were *partially agree with the statement*, as shown in the diagram below:

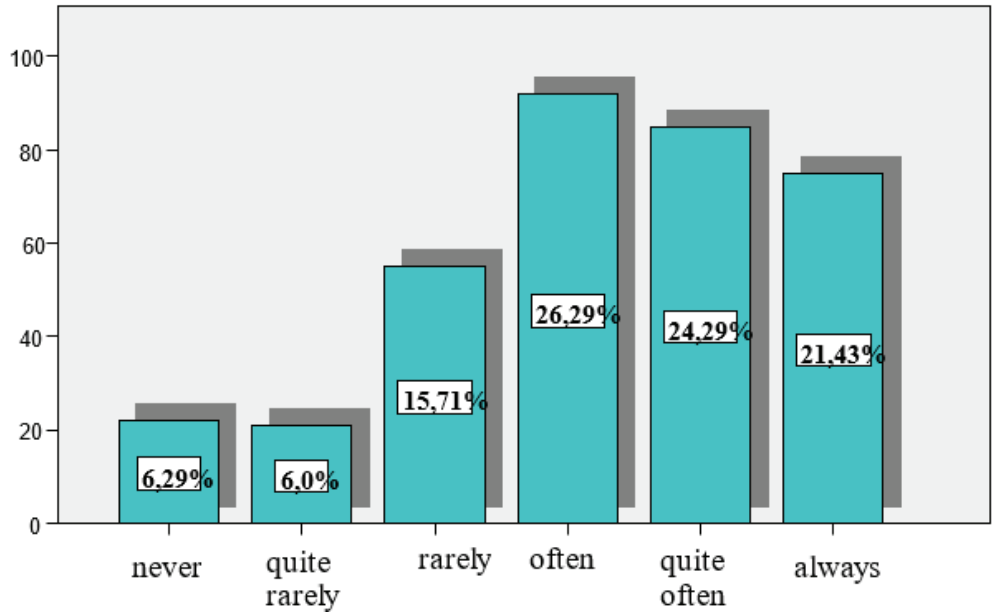

Figure 4. Frequency distribution on „attention paid to mathematics"

We notice that for over 70% of students, mathematics is a school subject to which they pay attention to a great extent, and over 21% of students say that they pay special attention to this subject. However, more than 25% of the subjects surveyed recognize that they rather neglect maths. This issue is very important for explaining students' poor results in maths, if we take into consideration the fact that there is a positive significant link ($\rho = .462$, $p < .01$), between the results obtained and the attention paid to this subject, as shown in Table 3.

Table 3. Correlation between „attention paid to mathematics" and „results obtained"

Spearman's rho		***mathematics is a subject to which I pay a special attention in my school training***
average score in maths in middle school	Correlation Coefficient	,462(**)
	Sig. (2-tailed)	,000
	N	350

** Correlation is significant at the 0.01 level (2-tailed).

A significant positive correlation ($\rho = .683$, $p < .01$) is identified between *the attention* students pay to school mathematics and their *confidence* that they can meet the specific requirements of math classes (Table 4). But it would be interesting to know the way in which the determination between the two variables is made: does the *confidence in their own abilities* make students *pay attention* to mathematics or is *the paying of attention increasing their confidence* that they can succeed, via *results obtained* in this subject?

Tabel 4. Correlation between „confidence in own abilities" and „attention paid to mathematics"

Spearman's rho		***mathematics is a subject to which I pay a special attention in my school training***
I consider myself able to cope with the requirements from math classes	Correlation Coefficient	,683(**)
	Sig. (2-tailed)	,000
	N	350

** Correlation is significant at the 0.01 level (2-tailed).

Conclusions

According to teachers, *curriculum* does not motivate students at a satisfactory level for learning mathematics, through the fact that knowledge values and tasks utilities are not explicit enough. This issue requires a deep reflection of both the curriculum designers and the mathematics teachers, in order to guide the learning finalities towards forming competences (knowledge, skills and attitudes), to select relevant contents and to correlate them with practical applications and to use teaching strategies which can justify the learning effort.

Another factor emphasized by teachers regards the adequacy between time resources and time required for a genuine learning. Under time pressure, learning is superficial, oriented towards performance goals (achieving high grades in assessments) and less on learning and thoroughgoing study, towards a conceptual understanding of mathematics.

Finally, in teachers' opinion, social motivation level influences students' learning motivation generally. This is a signal for parents, teachers, community on different degrees of extention, to become aware of the message they send to young

people in terms of attitude towards work, through the power of the model they offer.

Students consider that in terms of learning mathematics, they *are in control* of possibilities to fulfill this task and *take the responsability* for the results obtained, by believing that *anyone can learn mathematics,* but that it *requires a lot of effort* to achieve this. Also, most students see themselves able to meet the specific requirements from the math classes, but not all of them give special attention to this subject. This justifies the superficial training and the aim towards getting high grades in assessments, not always covered by mathematical knowledge.

The final conclusion of the study is that middle school students face *motiavtional obstacles* in learning mathematics, that are not as much related to their beliefs about mathematics or about self, as to the mathematics curriculum and the teaching strategies used. Students want and can learn mathematics, but the educational offer must meet their expectations and needs on a long term. A message for those who have this responsability!

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