Achievement and Attitude towards Mathematics in Early Adolescence: The Role of Classroom Environment and Goal Orientations

RUXANDRA LOREDANA GHERASIM, SIMONA BUTNARU, MIHAELA BOZA, LUMINIȚA MIHAELA IACOB
Faculty of Psychology and Educational Sciences, Alexandru Ioan Cuza University Iași, Toma Cozma Str., no. 3, 700554, Iași, Romania
ROMANIA
gloreda@uaic.ro  http://www.psih.uaic.ro

Abstract: This study investigated the contributions of classroom environment and achievement goal orientations, as well as the students’ performance in Mathematics and the students’ attitude. At the beginning of the first school semester, 171 eighth graders reported on their classroom environment and achievement goals. At the end of the first semester, the students filled in the scale on their attitude towards Mathematics. Also, their final Mathematics average grade was registered. The students’ performance avoidance and mastery goals were significant predictors of the achievement and attitude towards Mathematics. Also, classroom environment was directly related to the students’ grades in Mathematics. Furthermore, the results proved that classroom environment moderated the relationships between goal orientations and achievement in Mathematics. In the light of these findings, we discuss the importance of goal orientations in educational contexts.

Key-words: Classroom environment, Achievement goal orientations, Achievement in Mathematics, Attitude towards Mathematics

1. Introduction
Contemporary theories in educational sciences and the psychology of learning endorse the idea that achievement and skill acquisition are both mediated by personal characteristics and the learning environment. The more traditional approach, explaining achievement by skill alone, proved to be incomplete. This stands true even for a specialised field such as learning Mathematics, one of the seminal topics of psycho-pedagogical research. Therefore, our research approaches achievement in a more holistic way, through the ecological paradigm, aiming to identify the predictors of achievement in Mathematics. We stress that in Mathematics more than in other disciplines, the educational and socio-cultural background, including gender stereotypes, the social economic status, or the learning environment, might explain a considerable part of the variability of results, requiring culturally adapted research.

We believe that it is highly relevant to study the Maths performance in eight graders. Maths is of particular interest because the students perceive it to be a difficult subject compared to other disciplines. Also, the students’ enrollment in a high school of their choice depends on their composite academic accomplishment score that includes grades in Maths. Recent research showed that there are differences between boys and girls regarding Maths performance. It seems that boys are more able to flexibly apply their knowledge to non-standard problems, while girls outperform boys in standard computation, conventional problem solving and tend to receive higher classroom grades [1; 2]. However, girls have more negative attitudes towards Maths, lower confidence in mathematical ability in general, higher anxiety for Maths and are influenced by gender-based stereotypes [1; 3]. These divergent results might be partially explained by the measurements of Maths performance and the learning environment.

The attitude towards Mathematics was defined as “an aggregated measure of a tendency to engage in or avoid Mathematics activities, a belief that one is good or bad at Mathematics and a belief that Mathematics is useful or useless ” [4, p. 623]. More recently, researchers defined the attitude as students’ affective responses in the context of Mathematics learning - to self-concept, family support, and gender role in Mathematics [5]. Research indicated that there is a positive relationship between the attitude towards Maths and the achievement in Maths, but this relationship is rather complex and subject to multiple influences [5; 6; 7]. The results indicated that this relationship is stronger in
secondary students’ samples. Also, the studies conducted to determine the causal ordering between the attitude towards Maths and achievement in Maths showed that the achievement demonstrated a causal predominance over attitude across the entire secondary school [6]. In our research, the attitude towards Maths was considered as an outcome variable, along with achievement in Maths. In this study we explored how motivation and the learning environment may influence achievement and attitude towards Maths in early adolescence.

2. Problem Formulation

2.1. Theoretical background

2.1.1. Classroom environment
Classroom environment, shaped by teacher-students and students-students relationships, has been studied extensively and over a long time because of its effects on students’ outcomes mediated by motivational and affective mechanisms [8; 9; 10]. The meaningful classroom environment is able to meet basic psychological needs of children like competence, autonomy and relatedness [11]. Teachers, through the quality of their interactions with children and their choice of classroom practices, have the potential to create an environment that meets children's psychological needs, which may be reflected in children's social and academic outcomes [11; 12]. Adaptive behaviours such as task orientation and prosocial interactions (cohesion and equity) are more likely to increase in certain classroom environments. In these classrooms many students exhibit high levels of adaptive behaviour when they are reinforced by the teacher [13].

Greater engagement and achievement is typically related with high social support from peers and teachers, cohesiveness, belongingness, satisfaction and goal orientation in classroom [14; 9]. Students who feel socially supported by their teachers tend to exhibit a greater likelihood to comply with teachers’ expectations, which reduces the likelihood that these students will engage in distracting and deviant activities [9]. In a supportive and caring school environment, students have more positive attitudes towards academics. They identify themselves as belonging to the school because they can freely express themselves and they count on teachers for support on a range of problems [14; 15].

2.1.2. Achievement goal orientations
Achievement goal theories posit that students’ behaviour in an achievement setting is guided by the goals they construe for learning and these goals determine their approach to, engagement in, and evaluation of performance in school learning [16]. In literature, two major goal orientations have been identified that function in an achievement situation: mastery and performance goal orientations [10]. Mastery goals focus on the development of skills and abilities and define competence self-referentially, while performance goals focus on the demonstration of ability and define competence normatively [10]. The goal theorists divide performance orientation in performance-approach and performance-avoidance goals. This distinction is fundamentally based upon whether students want to look competent or avoid looking incompetent in their schoolwork [17; 10].

A number of studies demonstrated that the mastery goals are positively related to adaptive learning strategies, persistence on difficult tasks [17; 18] and having positive attitudes in relation to academic tasks [19]. The relationship between performance goals and outcomes has been less consistent. The performance-approach goals were linked to effort, positive exam performance, high levels of aspiration, intrinsic motivation, positive attitudes and valuing the academic work, while performance-avoidance goals exhibited a negative impact on intrinsic motivation and achievement [8; 19].

Contemporary studies investigated which pattern of achievement goal orientations is most adaptive with respect to learning. The findings are contradictory. In some of the studies, a superiority of the combined mastery and performance goal orientation pattern was found, in others a superiority of the mastery goal orientation, while in others no differences between mastery and performance goal orientation were found [20]. Moreover, it seems that students often endorse more than one type of achievement goals. The multiple-goals perspective states that the best characteristics of both mastery and performance orientations combined might work additively and may be the most adaptive for learning, better than the unique benefits of each goal orientation separately [19]. Research examined the relationships between the profiles of goal orientations and the students’ behaviour [21]. Their results showed that the goals related to self-improvement and mastery were positively associated with well-being, whereas avoidance tendencies were linked to different types of adjustment problems.
The potential benefits of personal achievement goals may depend on a number of factors, including the age of the students, whether the students are in a highly competitive context, and the types of skills that are valued in that context [22]. If the classroom activities emphasise relative ability, grades and performance, then students are likely to adopt performance-focused goals [10]. In contrast, in classrooms where task-mastery, effort and improvement are stressed, students are more likely to adopt mastery-focused goals [23; 24].

2.2. Objectives and Hypothesis

The present study examined whether classroom environment moderated the relationships between achievement goal orientations and the attitude towards Maths among adolescents. Specifically, it was hypothesised that among students who demonstrated high levels of performance avoidance goals, low level of performance approach or mastery orientations, those who perceived a low level of support from teachers would have lower achievements and a more negative attitude than students who perceived a high level of teacher support.

2.3. Method

2.3.1 Participants

Two hundred students were recruited at the beginning of the first semester of their eighth-grade year from two schools comprising children from various socioeconomic backgrounds within the same town. The students who were absent on one of the days of testing or provided incomplete data were excluded from the analyses. The final sample consisted of 171 eight-graders (89 girls and 82 boys; the average age was 14 years and 4 months).

2.3.2. Measures

Goal Orientations. The orientations towards mastery, performance-approach, and performance-avoidance goals at school were assessed with items adapted from the Patterns of Adaptative Learning Survey [17]. Each of the goal orientations were assessed with five items. All ratings were made on 5-point scales (1 - not at all true to 5 - very true). Chronbach’s alpha reliability for these factors ranged from .64 to .73. For this study, composite average scores were calculated for each of the goal orientations.

Classroom environment. To assess classroom environment, three scales from the What Is Happening In this Class? (WIHIC) were used [24]. The WIHIC consists of 56 items assigned to 7 underlying scales (8 items per scale). Each item employs a 5-point Likert response format (from 1 - almost never, to 5 - almost always). In this study we used data collection on three facets of classroom life, oriented mainly on the teacher’s behaviour: Teacher Support, Task Orientation and Equity. The average scores were calculated for each of the dimensions. In our study, the Cronbach alpha coefficients of these dimensions ranged from .68 to .81. For this study, a composite mean score was computed; the higher scores are reflective of greater perceived teacher support.

Maths achievement. Maths average grades were obtained for all the students at the end of the first semester from the school record office. The Romanian grading scale ranges from 1 (poor) to 10 (outstanding).

Revised Maths Attitudes Scale (RMAS). The RMAS is a 20-item Likert type scale developed by Aiken & Dreger [25] and revised by Aiken [26]. It is an one-dimensional measure of attitude towards Maths. The students were asked to rate the statements on a five-point scale ranging from 1 - strongly disagree to 5 - strongly agree. The higher the score, the more positive the attitude towards Maths is. Typical items on this instrument included questions asking whether Mathematics was an enjoyable or dreaded subject. In our study the Cronbach alpha for entire scale was .94.

2.3.3. Procedure

Questionnaires assessing goal orientations and classroom environment were administered to all the students at the beginning of the first semester of the eighth-grade. At the end of the first semester, 4 to 5 months after Time 1, the students completed the Math scale attitude. Also, students’ average grades for the entire first semester were recorded.

3. Problem Solution

Table 1 presents the summary statistics and the bivariate correlations among the study variables. No significant differences were detected between boys and girls on achievement goal orientations, perception of classroom environment and attitude towards Maths (all ps>.20). However, the girls’ Maths mean grades (7.44) were higher than those of the boys (6.66), as demonstrated by the independent t test, t(169)=2.79, p<.01.
Table 1. Correlations, means and standard deviations of analysed variables

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<thead>
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<td>1. PaP</td>
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<td>2. PaV</td>
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<td>.23**</td>
<td>-.17*</td>
<td>.23*</td>
<td>.47**</td>
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<tr>
<td>3. MG</td>
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<td>.24**</td>
<td>-.31**</td>
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<tr>
<td>4. MCh</td>
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<td></td>
<td>.04</td>
<td>-.17*</td>
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<tr>
<td>5. Maths Attitude</td>
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<td>-.04</td>
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<tr>
<td>Mean</td>
<td></td>
<td>3.59</td>
<td>2.95</td>
<td>3.52</td>
<td>3.53</td>
<td>7.06</td>
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<tr>
<td>SD</td>
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<td>.87</td>
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<td>1.85</td>
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</tbody>
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N=171; **p<.01; *p<.05; PaP - Performance-Approach, PaV - Performance-Avoidance, MG – Mastery Goals; ClEnv - Classroom Environment; MCh – Maths Achievement

Multiple regression analyses were used to test the hypothesis in this research [27]. First, a series of regressions were conducted to predict students’ Maths achievement. Secondly, other series of regressions were conducted to predict the attitude towards Maths. In each regression, the participants’ gender was introduced in the equation in Step 1; goal orientations were introduced in the equation in Step 2; classroom environment was introduced in Step 3 and the interactions between the predictors were introduced in Step 4.

Table 2: Hierarchical multiple regression analysis

<table>
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<tr>
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<th>Achievement</th>
<th>Maths Attitude</th>
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<tbody>
<tr>
<td></td>
<td>β</td>
<td>ΔR²</td>
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<tr>
<td>Step 1</td>
<td></td>
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<tr>
<td>Gender</td>
<td>.21**</td>
<td>.03**</td>
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<td>Step 2</td>
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<tr>
<td>PaP</td>
<td>.02</td>
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<tr>
<td>PaV</td>
<td>-.13*</td>
<td>-.21**</td>
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<tr>
<td>MG</td>
<td>.15**</td>
<td>.05</td>
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<tr>
<td></td>
<td>R²=.07, F(4,166)=4.32**</td>
<td>R²=.06, F(4,166)=3.69**</td>
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<tr>
<td>Step 3</td>
<td></td>
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<tr>
<td>ClEnv</td>
<td>.26**</td>
<td>.04**</td>
</tr>
<tr>
<td></td>
<td>R²=.11, F(5,165)=5.53**</td>
<td>R²=.06, F(5,165)=3.33**</td>
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<tr>
<td>Step 4</td>
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<tr>
<td>ClEnv *PaP</td>
<td>.09</td>
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<tr>
<td>ClEnv *PaV</td>
<td>-.15*</td>
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<tr>
<td>ClEnv *MG</td>
<td>-.06</td>
<td>.02</td>
</tr>
<tr>
<td></td>
<td>R²=.12, F(8,162)=4.00**</td>
<td>R²=.05, F(8,162)=2.24**</td>
</tr>
</tbody>
</table>

N=171; **p<.01; *p<.05; PaP - Performance-Approach, PaV - Performance-Avoidance; MG – Mastery Goals; ClEnv - Classroom Environment

4. Conclusion

The aim of our study was to explore whether the effects of goal orientations were mediated by classroom environment. Both performance avoidance and mastery goal orientations were significant predictors of the achievement and the attitude towards Maths. Students who reported more mastery goals and less performance-avoidance goals at Time 1 were more likely to have a higher level of achievement and a more positive attitude towards Maths four months later. These findings corroborate with previous research results which emphasise that the mastery goals have a fostering effect on achievement, task persistence and attitude [12; 19]. Performance-avoidance orientations are the least adaptive and are associated with a high level of anxiety and low performance [19; 21]. Our results replicate previous findings except for the performance approach. Our findings suggest that the combination between mastery and performance avoidance goals is more adaptive for the students [20; 21].

The perception of classroom environment predicted positively the students’ achievement in Maths. These results confirm the previous research that stresses the long-term and intricate effects of social support from teachers and peers on students’ social and academic outcomes [9; 11; 13]. The perception of classroom environment correlated positively with the students’ attitude towards Maths. Our results, as well as previous research, showed that a supportive and caring classroom environment is associated with a positive attitude toward academic activities [9; 14].

There is a significant effect of gender on Maths grades; girls had better grades in Maths compared to boys. These findings confirm the recent research showing that girls tend to receive higher grades in Maths [1; 2].

Our results showed that the effects of motivation were mediated by the learning
environment, but in a different way that we hypothesised. Students in a supportive classroom environment have better grades than in a non-supportive environment, regardless of their level of performance avoidance. Among students in a non-supportive classroom environment, those with a high level of performance avoidance orientation received lower grades than students with a low level of performance avoidance orientations. These results may be explained by the way of measuring the classroom environment, mainly through the teacher’s behaviour. As Mathematics is a discipline where the teacher is a trainer, with an important contribution to Maths comprehension, students’ achievement relies very much on the teacher’s performance. In classrooms where this support is weaker students have to compensate for this with a more proactive engagement translated as less avoidance.

Perceived classroom support did not mediate the relationships between mastery and performance-approach goal orientations and the achievement and attitude towards Maths. There may be a few possible explanations for these results. First, mastery goals are related to the intrinsic motivation, which is an individual characteristic and therefore, it is not significantly influenced by the students’ relationship with the teacher. Performance approach orientations are associated with the orientation to succeed and a positive attitude toward specific tasks, also insignificantly influenced by the teacher’s behaviour. Secondly, the assessment of classroom environment could explain these findings. This scale was based on the students’ self-evaluation of the teacher’s behaviour. Thirdly, there were not directly assessed a number of potentially other important aspects of classroom environment, such as goal structures or instructional practices that could mediate the impact of goals orientations on achievement and attitude. Future research will assess how these omitted classroom environment variables might interact with achievement goals in prediction of Maths achievement and attitude. Also, future research should investigate the impact of goal orientations and learning environment for each gender separately.

Despite the above limitations the finding that really stands out in this study is the importance of classroom environment and the goals orientations in relation to achievement. For this reason, teachers should make more effort to foster the development of high supportive classrooms focusing more on the mastery goals and less on the performance goals.

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