

STUDENTS' MOTIVATION AND ACHIEVEMENT AND TEACHERS' PRACTICES IN THE CLASSROOM

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This paper presents some preliminary results of a larger study that investigates the relationship between teachers' practices in the mathematics classroom and students' motivation and their achievement in mathematics. Data were collected from 321 sixth grade students through a questionnaire comprised of three Likert-type scales measuring motives, goals and interest, a test measuring students' understanding of fraction concept and an observation protocol observing teachers behaviour in the classroom. Findings revealed that the instructional practices suggested by achievement goal theory and mathematics education research promote both students' motivation and achievement in mathematics.

BACKGROUND AND AIM OF THE STUDY

According to Bandura's sociocognitive theory (1997), student's motivation is a construct that is built out of individual learning activities and experiences, and it varies from one situation or context to another. In line with this respect, the mathematics reform literature promotes practices presumed to enhance motivation, because high motivation is considered both a desirable outcome itself and a means to enhance learning (Stipek et. al., 1998).

Four basic theories of social-cognitive constructs regarding student's motivation have so far been identified: achievement goal orientation, self-efficacy, personal interest in the task, and task value beliefs (Pintrich, 1993). In this study we conceptualise motivation according to achievement goal theory because it has been developed within a social-cognitive framework and it has studied in depth many variables which are considered as antecedents of student motivation constructs. Some of these variables are students' inner characteristics concerning motivation (e.g. fear of failure and self efficacy), teacher practices in the classroom that are associated with students' adoption of different achievement goals and demographic variables (e.g. gender) (Elliot, 1999).

Achievement goal theory is concerned with the purposes students perceive for engaging in an achievement-related behaviour and the meaning they ascribe to that behaviour. A mastery goal orientation refers to one's will to gain understanding, or skill, whereby learning is valued as an end itself. In contrast, a performance goal orientation refers to wanting to be seen as being able, whereby ability is demonstrated by outperforming others or by achieving success with little effort (Elliot, 1999).

These goals have been related consistently to different patterns of achievement-related affect, cognition and behaviour. Being mastery focused has been related to adaptive perceptions including feelings of efficacy, achievement, and interest. Although the research on performance goals is less consistent, this orientation has been associated

with maladaptive achievements beliefs and behaviours like low achievement and fear of failure (Patrick et. al., 2001).

Environmental factors are presumed to play an important role in the goal adoption process. If the achievement setting is strong enough it alone can establish situation-specific concerns that lead to goal preferences for the individual, either in the absence of a priori propensities or by overwhelming such propensities (Elliot, 1999).

Goal orientation theorists (Ames, 1992) emphasize at least six structures of teacher practices that contribute to the classroom learning environment, namely Task, Authority, Recognition, Grouping, Evaluation, and Time (TARGET). Task refers to specific activities, such as problem solving or routine algorithm, open questions or closed questions in which students are engaged in; Authority refers to the existence of students' autonomy in the classroom; Recognition refers to whether the teacher recognizes the progress or the final outcome of students' performance and whether students' mistakes are treated as natural parts of the learning process by the teacher; Grouping refers to whether students work with different or similar ability peers. Evaluation refers to whether grades and test scores are emphasized by the teacher and made in public or whether feedback is substantive and focuses on improvement and mastery; Time refers to whether the schedule of the activities is rigid.

These instructional practices are similar to ones promoted by mathematics education reformers to achieve both motivational and mathematics learning objectives (Stipek et. al., 1998). Specifically, mathematics reformers have recommended that efficient mathematics teachers emphasize focusing on process and seeking alternative solutions rather than on following a set solution path. Moreover, efficient teachers press students for understanding, they treat students' misconceptions in mathematics and they use different visual aids in order to make mathematical learning more interesting and meaningful. Additionally, they give students opportunities to engage in mathematical conversations, incorporating students' erroneous solutions into instruction and giving substantive feedback rather than scores on assignments.

Moreover, there is some evidence that teachers' affect, like enthusiasm for mathematics and their sensitivity concerning students' treatment might affect students' emotions related to mathematics objectives (Stipek et. al., 1998). Yet, despite the evidence of association between students' motivation and important achievement-related outcomes (Stipek et. al., 1998), there is scarcity of research that studies in details how teachers influence their students' perception of the goals focusing on class work and on instructional practices that promote students' interest, self-efficacy, or students' fear of failure and all these vis-à-vis students' achievement.

In this respect the aims of the study were:

- To confirm the validity of the measures for the five factors: fear of failure, self-efficacy, mastery goals, performance approach goals, and interest, in a specific social context, and also to confirm the validity of a test measuring students' achievement in fraction concept.

- To identify differences among classrooms in students' motivation and achievement and examine teachers' practices to which these differences might be attributable.

METHOD

Participants were 321 sixth grade students, 136 males and 185 females from 15 intact classes. All students-participants completed a questionnaire concerning their motivation in mathematics and a test for achievement in the mid of the second semester of the school year.

The questionnaire for motivation comprised of five scales measuring: a) achievement goals (mastery goals) b) performance goals, c) self-efficacy, d) fear of failure, and e) interest. Specifically, the questionnaire comprised of 31 Likert-type 5-point items (1-strongly disagree, and 5 strongly agree). The five-item subscale measuring mastery goals, as well as the five-item measuring performance goals were adopted from PALS; respective specimen items in each of the two subscales were, "one of my goals in mathematics is to learn as much as I can" (Mastery goal) and "one of my goals is to show other students that I'm good at mathematics" (Performance goal). The five items measuring Self-efficacy were adopted from the Patterns of Adaptive Learning Scales (PALS) (Midgley et. al., 2000); a specimen item was "I'm certain I can master the skills taught in mathematics this year". Students' fear of failure was assessed using nine items adopted from the Herman's fear of failure measure (Elliot and Church, 1997); a specimen item was "I often avoid a task because I am afraid that I will make mistakes". Finally, we used Elliot and Church (1997) seven-item scale to measure students' interest in achievement tasks; a specimen item was, "I found mathematics interesting". These 31 items were randomly spread through out the questionnaire, to avoid the formation of possible reaction patterns.

For students' achievement we developed a three-dimensional test measuring students' understanding of fractions, each dimension corresponding to three levels of conceptual understanding (Sfard, 1991). The tasks comprising the test were adopted from published research and specifically concerned the measurement of students' understanding of fraction as part of a whole, as measurement, equivalent fractions, fraction comparison (Hanulla, 2003; Lamon, 1999) and addition of fractions with common and non common denominators (Lamon, 1999).

For the analysis of teachers' instructional practices we developed an observational protocol for the observation of teachers' mathematics instruction in the 15 classes during two 40-minutes periods. The observational protocol was based on the convergence between instructional practices described by Achievement Goal Theory and the Mathematics education reform literature. Specifically, we developed a list of codes around six structures, based on previous literature (Stipek et. al., 1998; Patrick et. a., 2001), which influence students' motivation and achievement. These structures were: *task*, *instructional aids*, *practices towards the task*, *affective sensitivity*, *messages to students*, and *recognition*. During classroom observations, we identified

the occurrence of each code in each structure. The next step of the analysis involved estimating the mean score of each code using the SPSS and creating a matrix display of all the frequencies of the coded data from each classroom. Each cell of data corresponded to a coding structure.

FINDINGS

With respect to the first aim of the study, confirmatory factor analysis was conducted using EQS (Hu & Bentler, 1999) in order to examine whether the factor structure yields the five motivational constructs expected by the theory. By maximum likelihood estimation method, three types of fit indices were used to assess the overall fit of the model: the chi-square index, the comparative fit index (CFI), and the root mean square error of approximation (RMSEA). The chi square index provides an asymptotically valid significance test of model fit. The CFI estimates the relative fit of the target model in comparison to a baseline model where all of the variable in the model are uncorrelated (Hu & Bentler, 1999). The values of the CFI range from 0 to 1, with values greater than .95 indicating an acceptable model fit. Finally, the RMSEA is an index that takes the model complexity into account; an RMSEA of .05 or less is considered to be as acceptable fit (Hu & Bentler, 1999). A process followed for the identification of the five factors including the reduction of raw scores to a limited number of representative scores, an approach suggested by proponents of SEM. Particularly, some items were deleted because their loadings on factors were very low (e.g. 1.3.18. and f.5.28). In addition some items were grouped together because they had high correlation (e.g. f.1.5 and f.3.17). Then in line with the motivation theory, a five-factor model was tested (fig. 1). Items from each scale are hypothesized to load only on their respective latent variables. The fit of this model was ($\chi^2 = 691.104$, $df = 208$, $p < 0.000$; CFI=0.770 and RMSEA=0.086). With the addition of correlations among the five factors the measuring model has been improved ($\chi^2 = 343.487$, $df = 198$, $p < 0.000$; CFI=0.931 and RMSEA=0.049).

Figure 1 shows that factor loadings range from 0.399 to 0.862. Students' interest is positively correlated with self-efficacy and negatively correlated with fear of failure. In addition, self-efficacy is negatively correlated with fear of failure. In conclusion, the existence of the five factors and their correlations has been verified in a different social context and supports the results of other studies (Elliot & Church, 1997; Elliot 1999).

To test the validity of the measure of students' achievement on the fraction test, we employed Rasch analysis for the entire sample so as to create a hierarchy of the items difficulty. The Rasch model is appropriate for the specification of this scale because it enables the researcher to test the extent to which the data meets the requirement that both students' performance on the items of the fraction test and the difficulties of the items form a stable sequence (within probabilistic constraints) along a continuum (Bond & Fox, 2001).

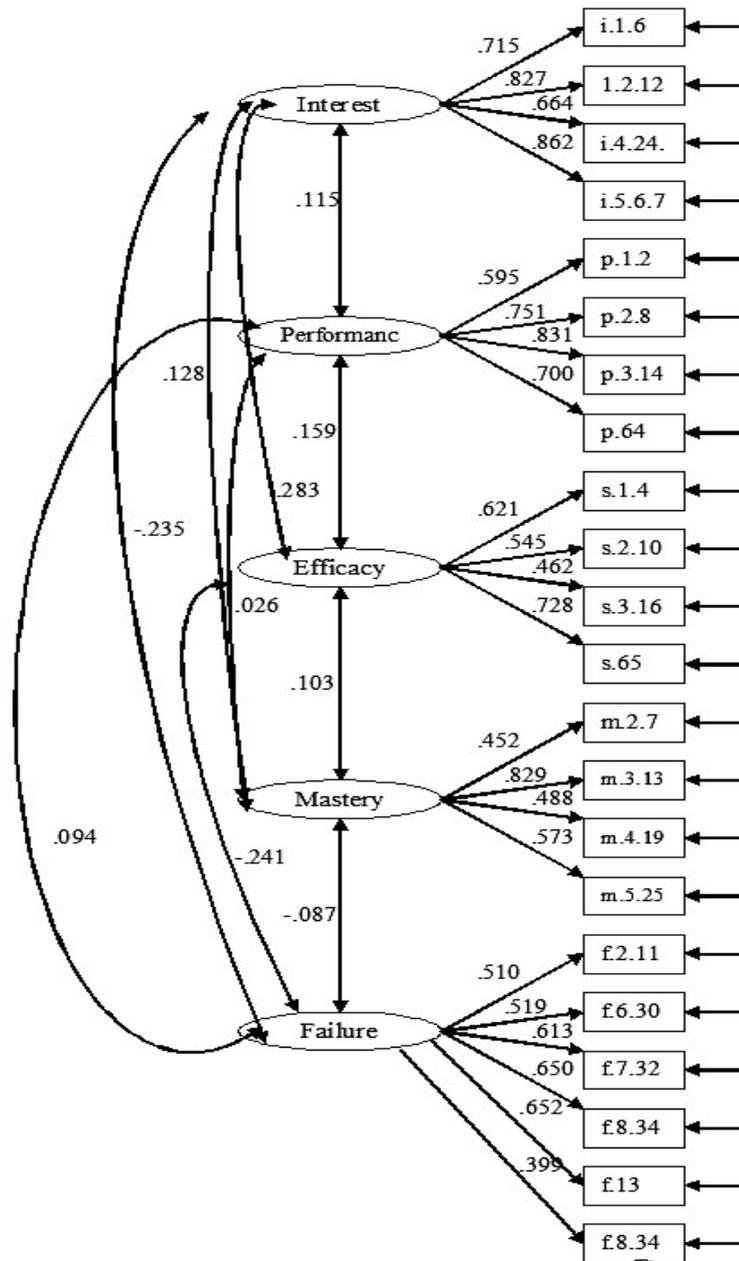


Fig.1. The factor model of students' motivation with factor parameter estimates.

We found that almost all students correctly answered three items at the easy end of the scale which involved tasks belonging to the interiorization level (94,4%, 89,7%, and 86,3%, respectively), and referred equivalence of fractions, comparison and addition of fractions with common denominators. On the other hand, only a small proportion of high achievers were able to get through the three items at the hard end of the scale, which involved tasks of the reification level (14,6%, 16,8%, and 18,1%, respectively). Specifically, these items addressed competence in fraction equivalence using the variable X, representing the addition of fractions with non common denominators and the comparison of fractions (all scales and the fraction test are available on request).

To examine the second aim of the study we used ANOVA, using LSD (Least significant difference) on the scores of each of the motivational constructs and the achievement test, to search for differences between the 15 classrooms. Significant

differences between classrooms were found in all five motivational constructs, namely in terms of mastery goals ($F=3,274$ $p<0,000$), performance goals ($F=6,018$, $p=0,000$), self efficacy beliefs ($F=3,368$, $p<0,000$), fear of failure ($F=2,545$ $p=0,002$), interest on mathematics ($F=4,377$ $p<0,000$) and achievement ($F=3,111$ $p<0,000$). The LSD method showed that students in class 14 declared the highest interest on mathematics and the highest self-efficacy beliefs. Students in class 3 were characterized by the highest performance goals, students in class 10 by the highest mastery goals and students in class 11 by the highest fear of failure. Table 1 presents the classes with the extreme means in each of the five motivational constructs.

Interest		Performance goals		Mastery goals		Self-efficacy		Fear of failure	
High	Low	High	Low	High	Low	High	Low	High	Low
Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
Class	Class	Class	Class	Class	Class	Class	Class	Class	Class
14	6	3	12	10	9	14	4	11	13
4,55	2,96	4	2,03	4,85	4,23	4,45	3,5	2,94	2,06

Table 1. Classes with the highest and lowest means in motivational measures

A first analysis of the observational data involved isolating the two classes at the highest and lowest extremes of specified motivational construct and comparing the means of each code in the six factors to identify commonalities and differences in teacher behaviours and instructional practices of the two classes. This approach is similar to the one used by Patrick et., al. (2001). In this study, we compare the instructional practices used by the teachers in classes 14, 6 and 3, 12 with respect to interest and performance goals, because these couples of classes exhibit the greatest difference between the highest and the lowest means.

The teacher in class 14 (highest student’s interest in mathematics) had 14 years of experience, a strong background in mathematics and a master’s degree, not in mathematics education. The teacher in class 6 (lowest student’s interest in mathematics) had 29 years of experience, and a low background in mathematics. As far as it concerns the task, both teachers used problem solving activities, open and closed questions, as well as drill and practice activities; One difference in instructional procedures was that teacher 14 tried to lead students to connect the new knowledge to existing, while teacher 6 used to do nothing about that, as well as to make connections between different mathematical ideas. Teacher 14 further made extensive use of various visual aids in the mathematics lesson, while teacher 6 avoided using any. Concerning practices towards the task, teacher 14 frequently asked students to provide reason for their choices and solution plans while teacher 6 focused on getting the correct answer without bothering about reasoning. Teacher 14 was also concerned about student’s understanding, something that was not at all observed in teacher 6 teaching. As far as it concerns affect both teachers were quite sensitive and respected students’ personality. With respect to messages sent to students, teacher 14 was clear to students that erroneous answers were part of the lesson while teacher 6 did not.

Concerning recognition, teacher 14 openly recognized students' efforts, e.g., making positive comments, while teacher 6 did not.

The teacher in class 3 (highest student's performance goals) had 18 years of experience and a strong background in mathematics while teacher 12 (lowest student's performance goals) had 29 years of experience and also a strong background in mathematics too. As far as it concerns task, both teachers used mostly problem solving activities, as well as open questions. Their difference in this respect was that teacher 12 tried to lead students to connect the new knowledge to existing and make connections between different mathematical ideas while teacher 3 failed to do that; instead he used more closed questions. Further, teacher 3 made use of visual aids in some extent, while teacher 12 did not use any. With respect to practices, teacher 12 frequently asked students to justify their answers while teacher 3 did not asked students for any justification. As far as it concerns affect teacher 12 was relatively more sensitive with students while teacher 3 was strict. In the category message, both teachers made clear to students that erroneous answers were part of the lesson. Finally, both teachers gave evidence that they recognize students' efforts.

As far as it concerns achievement, class 5 had the highest mean score (.881 out of 1) and class 13 the lowest (-.404 out of 1). Teacher in class 5 had 5 years of experience, a strong background in mathematics and a master's degree in educational psychology while teacher 13 had 32 years of experience and a low background in mathematics. As far as it concerns task, teacher in class 5 used mostly open questions while teacher 13 used closed questions; teacher 5 used plenty of visual aids while teacher 13 did not use any. In the structure teachers' practices, teacher 5 was pressing students for understanding and tried to clear students' misconceptions while teacher 13 did not made use of these practices. With regard to affect, the teacher in class 5 was more sensitive to students than teacher 13. As regards the messages sent to students, teacher 5 was clear to students that errors were part of the instruction while teacher 13 could hardly hide his rejection of errors. In respect to recognition teacher 5 frequently praised students' behaviour and built on their thinking.

DISCUSSION

In the present study we tried to shed some more light on students motivational environments by analysing questionnaire data and observations as a means towards identifying teachers' practices associated with the students' highest and lowest motivational constructs and achievement. The model found in this study that correlates the five motivational constructs is in line with other studies (Elliot & Church, 1997). The higher correlations identified in this study were between self-efficacy and fear of failure, and between interest and fear of failure. As it was expected, correlation between mastery and performance goals was small.

It emerged from the observations that there are certain teachers' practices, such as problem solving activities, the use of open questions, and the use of visual aids in the mathematics classroom, that seem to be positively associated with both students'

motivation and achievement. These findings confirm earlier findings by Partick et. al., (2001). Some important practices associated with high interest and achievement and low performance goals identified by this study were the connection of the new mathematical ideas with students' existing knowledge, pressing students for understanding and dealing with students' misconceptions. In addition the findings of the study suggest that a warm environment in which the teacher genuinely cares and respect students is associated with students' high interest, high achievement and low performance. The connection of affect to motivation and performance has been underlined by Stipek, et. al. (1998). Further investigation of teacher's practices in the classroom that are associated with students' motivation and achievement and the way these findings can be implemented in schools will take place in this on-going study.

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