Goal Orientation Beliefs and Mathematics Achievement: A Longitudinal Study

Shirley M. Yates
The Flinders University of South Australia

The influence of goal orientation beliefs upon mathematics achievement was investigated over almost three years. Task involvement, ego orientation and achievement in mathematics to achievement.were measured with an sample of 243 primary and lower secondary students. While task involvement correlated with achievement at a low but significant level, regression analyses revealed that this factor did not predict achievement over and above the prediction from the earlier *Progressive Achievement Test in Mathematics* score. At no stage did ego orientation relate

Student school performance has been found to be related to prior achievement, attitudes to specific aspects of school learning, and motivational factors (Keeves, 1972). Within motivational psychology, the importance of self-efficacy (Schunk, 1996), self regulation (Pintrich & Garcia, 1991; Zimmerman, 1990), self determination (Deci & Ryan, 1991), and causal attributions (Graham, 1991) have been emphasized. Goal theory has been advanced to explain the relationship between students' beliefs about the causes of school success, and their engagement and persistence in academic learning (Dweck, 1986). Adaptive patterns of achievement orientation have been variously termed mastery oriented goals (Ames, 1992), learning goals (Dweck, 1986) or task involvement (Nicholls, 1984), while maladaptive patterns have been referred to as performance oriented goals, performance goals , or ego orientation. The terms task involvement and ego orientation are used in this paper to exemplify goal orientation.

Task involvement goals have been distinguished from ego oriented goals in terms of students' conceptions of success, different reactions for approaching and engaging in achievement activity, and different ways of thinking about the self, the task and the task outcomes (Ames, 1992; Nicholls *et al.*, 1989). Task involvement goals are akin to "motivation to learn" as students focus on mastery and understanding content. Ames (1992) has suggested that effort and outcome covary, leading to stronger achievement directed behaviour over time. Students' attention is more likely to be focused on the intrinsic value of learning (Nicholls, 1984; Butler, 1988; Meece & Holt, 1990), and on effort utilisation, with the belief that effort leads to success and that mastery is intrinsic to self-efficacy. Task involved students are oriented towards the development of new skills, trying to understand their work, improving their level of competence or achieving a sense of mastery based on self referenced standards. Within this mental frame, students perceive ability as being improvable and incremental, and are more confident in investing or expending effort (Schunk, 1996).

Ego orientation, however, entails a focus upon ability as a fixed attribute which determines a sense of self-worth (Covington, 1984; Dweck, 1986; Nicholls, 1984). Ability is evidenced by doing better than others, by surpassing normative-based standards, or by achieving success with little effort (Covington, 1984). Ames (1992) has suggested that central to ego orientation is the need for public recognition, to be better than others, or to perform in a superior manner. Learning is viewed as a way to achieve normatively defined success. Effort becomes a double-edged sword as the self concept can be threatened if trying does not lead to immediate success (Covington & Omelich, 1979b). Over time, effort is seen as counterproductive, with increased effort interpreted as an indication of lack of ability.

Task involvement and ego orientation are not necessarily fixed characteristics, as they are influenced by conditions in school environments (Ames, 1992). Dweck (1986, 1989) considers that the nature of achievement goal orientation may change in relation to subject-matter areas, but Duda and Nicholls (1992) found that high school students' causal explanations of success were generalized across subject areas. Differences between ego oriented and task involved students were found in the amount of time students spend on learning tasks, persistence in the face of difficulty, quality of engagement in learning, and use of adaptive mental strategies (Butler, 1987; Elliott & Dweck, 1988; Meece *et al.*, 1988; Nolen, 1988; Nolen & Haladyna, 1990; Graham & Golan, 1991). Task involved students responded to impending failure by remaining task focused, while ego oriented students chose simpler tasks, used inefficient strategies, or preserved their self image by adopting an attitude of academic alienation (Dweck & Leggett, 1988). The adoption of task involvement goals could be expected to lead to long term achievement motivation in students, but the extent to which this relates to actual achievement is not clearly defined within the existing literature.

Factor analytic studies have determined that task involvement and ego orientation are independent dimensions of both personal academic goals and beliefs about the causes of school success (Nicholls *et al.*, 1989; Nicholls *et al.*, 1990), with the third dimension of work avoidance being found in mathematics achievement (Nicholls *et al.*, 1990). All three dimensions were only slightly correlated with perceived ability (Nicholls *et al.*, 1990). Goal theory researchers suggest that learning and performance goals are orthogonal rather than opposing ends of a continuum. (Maehr & Pintrich, 1991; Meece & Holt, 1993; Miller *et al.*, 1993). Four dichotomous goal configurations are thus possible, as any given student may be high on both dimensions, low in both or high on one and low on the other.

Within the field of mathematics, achievement has been examined in relation to school-type factors, curriculum considerations, student characteristics and background, and gender differences, but few studies have examined the relationship between goal orientation beliefs and achievement in mathematics (Bong, 1996). In an earlier study, Yates, Yates & Lippett (1995), found that ego and task goal orientation measures failed to correlate significantly with concurrently measured achievement in mathematics. The present study, part of a larger data set concerned with motivational variables in mathematics over a period of almost three years, investigated the extent to which achievement gain in mathematics could be predicted by goal orientation beliefs.

Method

Subjects: The study commenced in Term 1, 1993, with 328 students from Years 3, 4, 5, 6 and 7 in two primary schools in metropolitan Adelaide in South Australia. In 1995, 133 of these students were traced to 26 primary schools and 110 to 24 secondary schools in both the government and nongovernment sectors. Complete data was available for 243 students who then ranged from years 5 to 7 (primary) and 8 to 9 (secondary). The analyses of the *Feelings in Mathematics: A Questionnaire* was thus conducted on the initial 328 students, with the sample of 243 being used for the relational analyses.

Instrumentation: Progressive Achievement Tests in Mathematics: *Tests 1, 2, 3 (ACER, 1984.)* The Progressive Achievement Tests of Mathematics were adapted by the Australian Council for Educational Research (ACER) from the *Progressive Achievement Tests: Mathematics* developed by the Test Development Division of the New Zealand Council for Educational Research. The series, which utilised a multiple choice format, consisted of three tests at different levels of difficulty. Test 1 designed for Years 3 to 5 contained 47 items measuring number, computation, fractions, measurement and money, statistics and graphs, and spatial relations. The same topics with logic and sets added were covered by 57 items in Test 2, suitable for Years 5 to 8. Test 3, designed for Years 6 to 8, contained 55 items sampling the topics of number, computation, measurement and money, statistics and graphs, spatial relations, relations and functions, and logic and sets. Within each test, items were grouped by topic and arranged in increasing order of difficulty within each topic. The difficulty level was determined by the ACER from the Rasch analysis of responses from the standardisation sample tested in November, 1983.

Feelings in Mathematics: A Questionnaire. This 25 item questionnaire, a variant of the *Motivation Orientation Scales* developed by Nicholls (Nicholls *et al.*, 1990; Duda and Nicholls, 1992) was designed to measure task involvement and ego orientation. Each item commenced with the stem *"Do you really feel pleased in maths when ..."* followed by a statement reflecting either task involvement or ego orientation, with some filler items in random order. Students were required to rate each statement on a five point scale ranging from strongly agree to strongly disagree.

Administration of the Test and Questionnaire

At the commencement of Term 1, 1993, the *Progressive Achievement Tests in Mathematics* were administered to intact classes by a male researcher in one school, while the second school administered the tests as part of the normal procedures for the start of their academic year. The *Feelings in Mathematics: A Questionnaire* was then administered to intact classes in both schools by a male researcher. When the students were traced in 1995, the test and questionnaire were administered in Term 4 either by a male or female researcher. A standardised administration of Form A of Test 1, 2 or 3 of the *Progressive Achievement Tests in Mathematics* was given, with the level of the test chosen in accord with the student year level. All students in Year 9 took Test 3. Students recorded their responses in pencil on the ACER computer-scoring answer sheets.

Results

Achievement in Mathematics

The raw scores from the *Progressive Achievement Test in Mathematics* for 1993 and 1995 were converted to scaled scores, using the table from the *Teachers Handbook* (ACER, 1984). During the standardisation process, the scaled scores had been calibrated for difficulty with the Rasch model calibration program BICAL3, using the common-items linking procedure. The scores for the Forms 1, 2, and 3 were thus able to be placed on a single scale for both 1993 and 1995. Mean achievement scores for 1993 and 1995 were then calculated and compared in relation to year level and gender. When the scores were analysed with one way analysis of variance, a significant relationship between year level and achievement in both 1993 and 1995 was apparent (see Table 1). However there was no significant relationship between gender and mathematics achievement.

Table 1 Analysis of variance for year level and gender in relation to mathematics achievement in 1993 and 1995

1993 Mathematics achievement n = 243	df	F	Significance of F
1993 Year level	4	51.66	<0.00
Gender	1	1.50	ns
1995 Mathematics achievement			
1995 Year level	4	18.62	<0.00
Gender	1	1.93	ns

The predictive relationship between achievement in 1993 and 1995 was substantiated with multiple regression using direct entry of the variables, although the year level and gender variables were not significant (see Table 2).

Table 2 Multiple regression analysis of year level, gender and mathematics achievement in 1993 on mathematics achievement in 1995

n = 243		Beta	r	t	Significance of t
1993 Mathematics achievement		0.75	0.74	13.37	<0.00
1993 Year level		0.20	0.43	1.42	ns
Gender		-0.32	-0.06	0.74	. ns
Multiple R = 0.74	R square	= 0.55			

The Feelings in Mathematics Questionnaire

Factor analysis was employed to examine the unidimensionality of the questionnaire. Principal components analysis and the oblimin rotation revealed two major factors of task involvement and ego orientation, with eigen values of 7.47 and 2.36 respectively. The two factors correlated at 0.40. As items 2, 7, 11 and 25 did not contribute to either of these factors they were deleted. On the basis of the factor analysis results, the remaining items were divided into two unidimensional scales. Each scale was Rasch analysed separately with the rating scale model of the QUEST program (Adams & Khoo, 1993), using the data from the 328 students (see Tables 3 and 4).

Task Involvement in Mathematics: Items 16, 20 and 21 were deleted from the 15 items task involvement scale as their item infit mean square values were outside the acceptable range of 0.83 to 1.20. Thus the final scale for task involvement was composed of 12 items (see Table 3).

Table 3 Task involvement in mathematics
Item analysis of the 15 item 1993 rating scale

n=328		First analysis		Final analysis	
Item No.	Do you really feel pleased in maths when...	Infit mean square	Discrim. index	Infit mean square	Discrim. index
1	you really get busy with the work	1.06	0.55	1.12	0.54
3	you really understand things	0.97	0.51	0.94	0.54
5	you learn new things about mathematics	1.06	0.52	1.04	0.56
6	what the teacher says makes you think hard	0.94	0.66	0.96	0.66
9	the problems make you think hard	0.96	0.66	1.03	0.66
10	you are making good progress in learning difficult things	1.04	0.52	1.03	0.55
13	you find a new way to solve a problem	1.02	0.52	1.02	0.54
15	something you learn makes you want to find out more	.95	0.62	1.02	0.62
16	you solve a problem by working hard	.73	0.70	Deleted	
17	something you find out really makes sense	1.01	0.55	1.00	0.55
18	you work hard all the time	0.92	0.63	0.94	0.65
20	the teacher looks at your work	1.16	0.53	Deleted	
21	the teacher says its time for a test	1.32	0.52	Deleted	
22	you try your hardest	0.91	0.58	0.90	0.61
24	the teacher says you are doing excellent work	0.95	0.46	0.93	0.48

Estimated scores for each student were then calculated on the basis of these 12 items, with the case estimates being derived by the concurrent equating method. The 1993 and 1995 data files were combined, the case estimates calculated from the 486 cases and the scores determined for each subject for the two occasions on the basis of these estimates. Concurrent methods have been found to yield stronger estimates than equating based on anchor item equating procedures (Mohandas, 1996).

Ego Orientation in Mathematics: When the six items that composed the ego orientation scale were analysed with the Rasch procedure, item 14 was deleted as it had an infit mean square greater than 1.20 (see Table 4). The final scale for ego orientation was thus composed of five items. Estimate scores for each student were then calculated on the basis of these five items, with the case estimates being derived from the same concurrent equating method that was used for the task involvement scale.

Table 4 Ego orientation in mathematics
Item analysis of the 1993 rating scale

n=328		First analysis		Final analysis	
Item No.	Do you feel really pleased in maths when...	Infit mean square	Discrim. index	Infit mean square	Discrim. index
4	you know more than the others	0.91	0.75	0.94	0.79
8	you do better than the other children	0.85	0.77	0.88	0.80
12	you are the only one who can answer a question	1.05	0.70	1.11	0.73
14	you can see others making mistakes	1.49	0.59	Deleted	
19	you finish before your friends	1.03	0.74	1.17	0.75
23	you score better on the test than others	0.81	0.77	0.89	0.79

Stability of the Task Involvement and Ego Orientation Measures: When measured with intraclass and interclass correlations, neither task involvement nor ego orientation between 1993 and 1995 was particularly stable, although the task involvement scale was more robust over time (see Table 5).

Table 5 Intraclass correlations between task involvement and ego orientation in 1993 and 1995

n = 243	F	r (rho)	r
Task involvement	1.92	0.32	0.34
Ego orientation	1.45	1.18	0.20

The Relationship between Mathematics Achievement and Goal Orientation in 1993 with Achievement in and Goal Orientation towards Mathematics in 1995

The relationships between the measures of achievement and goal orientation towards mathematics in 1993 were examined by bivariate correlations (see Table 6), and by multiple regression (see Tables 7 and 8). There was a weak correlation between mathematics achievement and task involvement for both 1993 and 1995. Ego orientation failed to correlate significantly with achievement in either year (see Table 6).

Table 6 Correlations between achievement, task involvement and ego orientation in mathematics in 1993 and 1995

n = 243	2	3	4	5	6
1 1993 Maths achievement	0.74***	0.13*	•	•	•
2 1995 Maths achievement		0.18**	0.13*	•	•
3 1993 Task involvement			0.39***	•	•
4 1995 Task involvement				0.27***	0.26***
5 1993 Ego orientation					0.20**
6 1995 Ego orientation					-

* p <.05, ** p <.01, *** p <.001 , • correlation not significant

The relationships between achievement, task involvement and ego orientation was then examined with direct entry multiple regression for both 1993 and 1995 (see Table 7). Mathematics achievement was most strongly predicted by prior performance in 1993, but neither task involvement nor ego orientation measured in 1993 significantly added to the prediction of achievement in 1995.

Table 7 The influence of mathematics achievement, task involvement, and ego orientation in 1993 on mathematics achievement in 1995

n - 243	Beta	r	t	Sig. of t
1993 Mathematics achievement	0.73	0.73	16.39	0.00
1993 Task involvement	0.08	0.18	1.78	ns
1993 Ego orientation	0.02	-0.03	0.51	ns
Multiple R = 0.74 R square	= 0.55			

The data were then analysed by multiple regression to determine the effects of the three measures in 1993 on both task involvement and ego orientation respectively in 1995 (see Table 8). While there was no significant relationship between mathematics achievement and the two indices of goal orientation, there was an interesting relationship between the measures of task involvement and ego orientation. Both task involvement and ego orientation in 1993 influenced task involvement in 1995, while ego orientation in 1995 was predicted by ego orientation in 1993 only.

Table 8 The influence of mathematics achievement, task involvement and ego orientation in 1993 on task involvement in 1995 and ego orientation in 1995

1995 Task involvement	**Beta**	**r**	**t**	**Significance of t**
1993 Mathematics achievement	0.02	0.04	0.39	ns
1993 Task involvement	0.29	0.34	4.70	0.00
1993 Ego orientation	0.20	0.27	3.31	0.00
Multiple R = 0.39 R square = 0.15				
1995 Ego orientation				
1993 Mathematics achievement	-0.04	-0.06	-0.64	ns
1993 Task involvement	-0.06	-0.02	-0.87	ns
1993 Ego orientation	0.19	0.20	2.93	0.00
Gender	1.45	-0.16	2.29	0.02
Multiple R = 0.24 R square = 0.06				

Discussion

*1. **Mathematics Achievement***: Achievement in mathematics in 1993 was strongly predictive of achievement in mathematics in 1995. Analysis of variance indicated that achievement in both 1993 and 1995 was significantly related to the year level of the students but not to their gender.

*2. **Goal Orientations and Achievement in Mathematics:*** Weak but significant correlations were found between task involvement and concurrent achievement ($r = 0.13$ in both cases). Ego orientation did not correlate with achievement in either 1993 or 1995. Overall, goal orientation in mathematics as measured by the task involvement and ego orientation constructs was not related to year level or gender.

*3. **The Influence of Achievement in Mathematics, Task Involvement and Ego Orientation in 1993 on Achievement in Mathematics, Task Involvement and Ego Orientation in 1995:*** Once prior achievement was included in the regression equation, task involvement failed to add to the prediction of subsequent achievement. Task involvement in 1995 was predicted by both task involvement and ego orientation in 1993, while ego orientation in 1995 was predicted only by the same measure in 1993.

Further evidence was found for the remarkably strong impact of past achievement on current achievement, a relationship borne out despite the fact that the majority of students were tested on different forms of the *Progressive Achievement Test in Mathematics,* with the scores equated with the common Rasch-derived scale. These data thus make a further contribution to the known validity of this mathematics achievement instrument.

Goal orientation data, in the form of task involvement and ego orientation questionnaire measures, failed to add to the prediction of achievement over time. Task involvement significantly correlated with achievement across both time phases, but failed to account for additional variance in the 1995 achievement data once the effect of prior achievement was taken into account. Ego orientation similarly did not add to the prediction of achievement gain over time. Overall, the current data suggest that it would be unwise to make predictions of future performance changes in achievement domains from simple questionnaire measures of dispositional goal orientation.

The two goal orientation measures were based on a trait theory assumption that it is possible to measure goal orientations in order to infer enduring dispositions. However, as other goal theory researchers have regarded goal dimensions as situationally induced states, the extent to which students can be meaningfully assigned to dispositional categories such as "ego oriented" and "task involved" is unknown. It is very likely that goal orientation measures relate meaningfully to achievement gain, but uncovering the nature of this relationship will require more complex designs and measures. Linkages between dispositional goal orientations and achievement gain could possibly be mediated by environmental conditions such as classroom climate and perceived competitiveness that were not addressed in this study.

Significance of the Study

1. The strong influence of prior performance was evident for mathematics over a three year period for students from primary to lower secondary school.
2. While task involvement did correlate with the contiguous measure of mathematics achievement in 1993, it did not predict subsequent achievement over and above the effects of prior achievement. Ego orientation failed to correlate with achievement at any time. This finding however, must be tempered by the evidence that the measures were only weak to moderately stable across time, and the ego measure in particular was based on only a small number of items.
3. The study has made a significant contribution to the goal orientation literature, particularly given the longitudinal nature of the design.
4. While the present findings failed to give strong support to the notion that dispositional goal orientations were predictive of achievement gain, the extent to which goal orientation measures can be regarded as having trait-like qualities is a matter as yet undecided.

References

Adams, R. J. & Khoo, S. (1993). *Quest: The interactive test analysis system.* Melbourne: ACER.

Ames, C. (1992). Classrooms: Goals, structure, and student motivation. *Journal of Educational Psychology,* **84**, 261-271.

Ames, C., & Archer, J. (1987). Mothers' beliefs about the role of ability and effort in school learning. *Journal of Educational Psychology,* **79**, 409-414.

Bong, M. (1996). Problems in academic motivation research and advantages and disadvantages of their solutions. *Contemporary Educational Psychology,* **21**, 149-165.

Butler, R. (1987). Task-involving and ego-involving properties of evaluation: Effects of different feedback conditions on motivation, perceptions, interest, and performance. *Journal of Educational Psychology*, **79**, 474-482.

Covington, M. V. (1984). The self-worth theory of achievement motivation: Findings and implications. *Elementary School Journal*, **85**, 5-20.

Covington, M. V. & Omelich, C. L. (1979). Effort: The double-edged sword in school achievement. *Journal of Educational Psychology,* **71**, 169-182.

Deci, E. L. & Ryan, R. M. (1991). A motivational approach to self:. In R. A. Dienstbier (Ed.), *Nebraska Symposium on Motivation 1990* (pp 149-1760. Hillsdale, NJ: Lawrence Erlbaum.

Duda, J. L. & Nicholls, J. G. (1992). Dimensions of academic motivation in school work and sport. *Journal of Educational Psychology,* **84**, 290-299.

Dweck, C. S. (1986). Motivational process affecting learning. *American Psychologist,* **41**, 1040-1048.

Dweck, C. S. (1989). Motivation. In A. Lesgold, & R. Glaser (Eds.), *Foundations for a psychology of education.* Hillsdale, NJ: Erlbaum.

Dweck, C. S. & Leggett, E. L. (1988). A social-cognitive approach to motivation and personality. *Psychological Review*, **95**, 256-273.

Elliott, E. S. & Dweck, C. S. (1988). Goals: An approach to motivation and achievement. *Journal of Personality and Social Psychology,* **54**, 5-12.

Graham, S. (1991). A review of attribution theory in achievement contexts. *Educational Psychology Review*, **3**, 5-39.

Graham, S., & Golan, S. (1991). Motivational influences on cognition: Task involvement, ego orientation, and depth of information processing. *Journal of Educational Psychology*, **83**, 187-194.

Keeves, J. P. (1972). *Educational environment and student achievement.* Melbourne: ACER.

Meece, J. L. & Holt, K. (1993). A pattern analysis of students' achievement goals. *Journal of Educational Psychology,* **85**, 582-590.

Meece, J. L., Blumenfeld, P. C., & Hoyle, R. (1988). Student's goal orientations and cognitive engagement in classroom activities. *Journal of Educational Psychology,* **80**, 514-523.

Miller, R. B., Behrens, J. T., & Greene, B. (1993). Goals and perceived ability: Impact on student valuing, self-regulation, and persistence. *Contemporary Educational Psychology*, **18**, 2-14.

Mohandas, R. (1996). *Test equating, problems and solutions: Equating English test forms for the Indonesian Junior Secondary final examination administered in 1994.* Unpublished MEd thesis. Flinders University of South Australia.

Nicholls J. G. (1984). Conceptions of ability and academic motivation. In R. Ames & C. Ames (Eds.), *Research on motivation in education: Vol. 1. Student motivation.* Orlando, Fl: Academic Press.

Nicholls, J. G., Cheung, P. C., Lauer, J., & Patashnick, M. (1989). Individual differences in academic motivation: Perceived ability, goals, beliefs, and values. *Learning and Individual Differences,* **1**, 63-84.

Nicholls, J. G., Cobb, P., Wood, T., Yackel, E., & Patashnick, M. (1990). Assessing student's theories in mathematics: Individual and classroom differences. *Journal for Research in Mathematics Education,* **21**, 109-122.

Nolen, S. B. (1988). Reasons for studying: motivational orientations and study strategies. *Cognition and Instruction*, **5**, 269-287.

Nolen, S. B., & Haladyna, T. M. (1990). Motivation and studying in high school science. *Journal of Research on Science Teaching*, **27**, 269-287.

Pintrich, P. R. & Garcia, T. (1991). Student goal orientations and self-regulation in the college classroom. In M. L. Maehr & P. R. Pintrich (Eds), *Advances in motivation and achievement. Vol 7* (pp 371-402). Greenwich, CT: JAI Press.

Schunk, D. H. (1996). *Learning theories: An educational perspective.* Englewood Cliffs, NJ: Merrill

Yates, S. M., Yates, G. C. R., & Lippett, R. M. (1995). Explanatory style, ego-orientation and primary school mathematics. *Educational Psychology,* **15**, 28-34.

Zimmerman, B. J. (1990). Self-regulated academic learning and achievement: The emergence of a social cognitive perspective. *Educational Psychology Review*, **2**, 173-201.

Acknowledgements

This study was supported by a Flinders University of South Australia Research Board Establishment Grant to Shirley M. Yates in 1995.

Thanks are extended to Professor John Keeves for his expert knowledge, kind patience and encouragement throughout the project.

Thanks are also extended to Mr Ron Thomas, to Milton Yates, and to the staff and students in the 50 schools, without whom the study would not have been possible.