

Boys' Motivational Goals in Mathematics During the Transition from Single Sex Education to Co-Education

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Boys' task involvement and ego orientation motivational goals in mathematics were measured prior, during and one year after the introduction of co-education to a single sex boys' school. All primary and secondary boys enrolled in Grades 3 to 10 in the single sex school were followed over the three-year period. Comparisons were made over time across grades and cohorts with analysis of variance and hierarchical linear modelling. While there were significant effects for boys' task involvement in the transition from single sex to co-education, particularly at the primary school level, there were no significant changes in boys' ego orientation goals.

Gender differences have long been of concern in mathematics education (Forgasz, 1997). Numerous studies have investigated boys' and girls' achievement, participation rates, motivation, self concept, self esteem, confidence, goal orientations, attributional style, reactions to success and failure in mathematics, as well as a range of other teacher and classroom variables (McLeod, 1992). Several societal, contextual, affective and cognitive variables have been identified that interact with gender to influence the mathematics learning outcomes of boys and girls (Barnes & Horne, 1996; Leder, Forgasz & Solar, 1996). Single sex and co-educational contexts of learning have also been considered, including the introduction of single sex mathematics classes within co-educational systems and the transition from single sex education to co-education. However, in these contextual and transitional studies, boys' motivational mathematics goal orientations have not been investigated.

Motivational Goal Orientations in Mathematics

“Motivation is a theoretical construct used to explain the initiation, direction, intensity and persistence of behaviour, especially goal-directed behaviour” (Brophy, 1998, p.3). Goal orientation theory posits a relationship between beliefs about the causes of school success, and students' engagement and persistence in academic learning. Students' espoused goals affect the quality of their motivation (Dweck, 2000), which in turn influences behavioural, cognitive and affective outcomes (Urdu, 1997). Task involvement and ego orientation goals are important motivational constructs in mathematics, as they reflect students' reasons to achieve mastery of the subject matter, to be competitive with their fellow students or to do both (Nicholls, Cheung, Lauer & Patashnick, 1989; Nicholls, Cobb, Wood, Yackel & Patashnick, 1990).

Students with task involvement goals strive to achieve understanding and gain mastery in their learning, while students holding ego oriented goals focus on their performance relative to others (Duda & Nicholls, 1992). Ego orientated students need to appear successful, to be better than others and to avoid failure in the classroom. They are motivated only when their performance is being evaluated and they choose tasks and expend effort accordingly (Stipek, 1996). They are less likely to attempt difficult tasks, as the need to expend effort is tantamount to an admission of a lack of ability (Covington &

Omelich, 1979). They are also more likely to believe that ability is fixed (Dweck, 2000; Pintrich & De Groot, 1990). By early adolescence some students have begun to purposefully withdraw effort and avoid seeking help in mathematics (Turner, Midgley, Meyer, Gheen, Anderman, Kang & Patrick, 2002). By contrast, task involved students espouse learning goals which motivate them to learn, improve, seek challenges, persist in the face of difficulty and to focus on mastery of the topic or task (Nicholls & Miller, 1984). They are also more likely to believe that ability is incremental (Dweck, 2000) and to seek appropriate assistance (Butler & Neuman, 1995). In a recent longitudinal study boys were found to have less task involvement and lower achievement in mathematics than girls. (Yates, 2000a; 2002).

Single Sex Education and Co-Education

Differences have been found in boys' and girls' ratings of their achievement (Foon, 1988), attitudes and beliefs (Forgasz, 1995) in mathematics in single sex and co-educational settings. A substantial research literature suggests that in co-educational classrooms boys receive more academic support from teachers, different patterns of teacher feedback and different forms of assigned academic tasks than girls (Good, Nichols & Sabers, 1999). Recent studies of single sex and mixed sex mathematics classrooms in co-educational secondary schools found both teachers and students perceived single sex classes to be generally less supportive for boys than girls (Rennie & Parker, 1997; Jackson & Smith, 2000). However, other evidence has indicated that school type does not benefit either boys or girls once other variables are controlled (Marsh, 1989; Marsh & Rowe, 1996).

No significant differences in boys' and girls' mathematics' achievement were found during and after the merger of two single sex schools into two co-educational secondary schools (Marsh, 1989; Marsh, Smith, Marsh & Owens, 1988). A small decrease in self-concept was evident for students in co-educational classes in the transitional year, but overall multidimensional self-concepts increased in the co-educational setting. In a similar study, girls from a single sex secondary school maintained positive attitudes towards mathematics following amalgamation with a single sex boys' school, but reported feeling intimidated, hesitant, uncomfortable and dumb during mathematics lessons in the mixed sex classrooms (Steinbeck and Gwizdala, 1995). They also perceived that teachers gave more attention to the boys. Perceptions of disadvantage within co-educational settings have been mirrored by girls in other studies (Milligan & Thomson, 1992; Parker & Rennie, 1995; Forgasz & Leder, 1996; Gill, 1996). However, boys' and girls' goal orientations in mathematics have not been considered in studies of single sex and co-educational school contexts.

Aim

To investigate, through a longitudinal design, the goal oriented motivational beliefs of primary and secondary school boys during the transition from single sex education to co-education.

Method

The study, conducted over three consecutive years, commenced in the year prior to the introduction of co-education to a non-government single sex boys' school in South Australia. The school was located on two separate primary and secondary campuses. Data

were collected from all boys in Grades 3 to 10 in the fourth term of that year (T1) and from the same boys for the following two years (T2 and T3 respectively). At T2 the boys were in Grades 4 to 11 and at T3, Grades 5 to 12. Table 1 presents the numbers participating and their respective grades at T1, T2 and T3.

Table 1

Number of Boys by Grade Level at Time 1, Time 2 and Time 3

Grs	3,4,5	4,5,6	5,6,7	6,7,8	7,8,9	8,9,10	9,10,11	10,11,12	Total
T1	44	37	42	40	67	76	63	73	442
T2	33	40	37	56	59	65	55	65	410
T3	42	39	38	38	49	64	53	50	373

There is some variability in the student numbers over the three year period. Student ID numbers used for data entry in SPSS (Norusis, 1993) were generated from school class lists at T1. Some students were absent at T1, T2 or T3 or may have left the school altogether at T2 or T3. There are, however, sufficient numbers of students at each grade level on each occasion for the statistical analyses to be conducted.

The task involvement and ego orientation dimensions of student goal orientations towards mathematics were measured with *Your Feelings in Mathematics: A Questionnaire* (Yates, 2000b; Yates, Yates & Lippett, 1995), a 25 item variant of the *Motivation Orientation Scales* (Nicholls, Cobb, Wood, Yackel, & Patashnick; Duda and Nicholls, 1992). Student competitiveness was sampled by six ego orientation items while the extent to which they were interested in and engaged in learning mathematics was measured by fifteen task involvement goal items. The questionnaire also contained four filler items in random order. Each item commenced with the stem *Do you really feel pleased in maths when ...* followed by a statement that related to student mathematics behaviour. Typical task involvement items were: (Item 1) *you get really busy with the work* and (Item 15) *something you learn makes you want to find out more*. Ego orientation in mathematics items included: (Item 12) *you are the only one who can answer a question*; and (Item 23) *you score better on a test than others*. Students rated their motivation towards mathematics on a five point scale ranging from (1) a *strong no* to (5) a *strong yes*.

Procedure

Your Feelings in Mathematics: A Questionnaire (Yates, Yates & Lippett, 1995) was administered to the boys either by their classroom teachers or by a research assistant on the same day in the fourth term of each year of the study.

Analyses

Factor analysis of *Your Feelings in Mathematics: A Questionnaire* indicated two separate subscales of *Task Involvement* (TK) and *Ego Orientation* (EGO) (Yates, 1997; Yates & Yates, 1996). TK and EGO were calibrated separately with the Rasch scaling procedure (Rasch, 1966) to bring each to a logit scale with interval properties, which then allows for comparison between grade levels as well as across time. Thirteen TK and five EGO items met item response theory requirements, with misfitting items 20 and 21 deleted from the TK scale and item 14 from the EGO scale.

Students' responses to the TK and EGO scales were equated concurrently across the three occasions as this yields stronger case estimates than common item difference or anchor item equating methods (Mohandos, 1996). Rasch case estimate scores were used in the analysis of variance (ANOVA) (Norusis, 1993), and Hierarchical Linear Modelling (HLM5) (Raudenbush, Bryk, & Congdon, 2000) procedures.

Results

Results are examined in terms of grade level and group differences in Task involvement and Ego orientation in the context of single sex education at T1, in the transition to co-education at T2 and following co-education at T3. Figures 1 and 3 present TK and EGO across Grades 3 to 12 at Time 1, 2 and 3 respectively, with Figures 2 and 4 presenting TK and EGO respectively for each Grade level cohort (group) across the three years of the study.

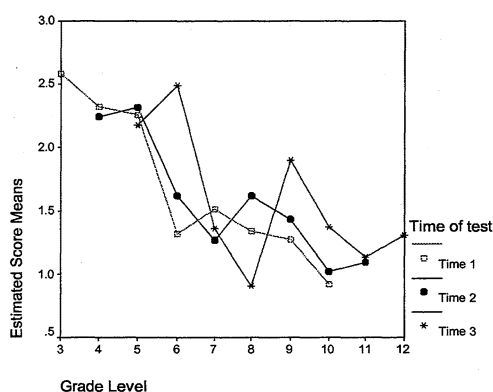


Figure 1. Task involvement at time 1, 2 & 3.

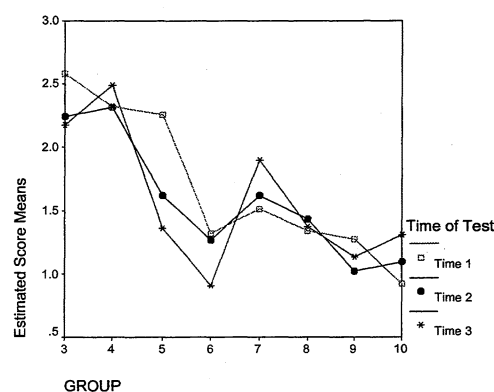


Figure 2. Task involvement by grade cohort.

Table 2

Significant Coefficients for Intercepts for Task Involvement by Grade at T1, T2 & T3

	Coefficient	Std Error	T-ratio	Approx d.f.	p-value
Grade 3	1.41	0.32	4.38	5	0.008
Grade 4	1.07	0.22	4.77	5	0.004
Grade 5	1.00	0.15	6.45	5	0.000
Grade 9	0.40	0.133	3.00	5	0.032

Table 3

Significant Coefficients for Intercepts for Task involvement by Grade Cohort

	Coefficient	Std Error	T-ratio	Approx d.f.	p-value
Grade 3	1.23	0.16	7.19	4	0.000
Grade 4	1.17	0.16	7.30	4	0.000
Grade 5	1.29	0.34	3.8	4	0.032

Task Involvement

In Figures 1 and 2 there is an overall pattern of a decrease in TK across the grade levels for all three years of the study. However, the impact of the transition to co-education is quite variable across the school both in relation to the Grade levels from T1 to T2 and T3 in Figure 1 and the Grade cohorts in Figure 2. Univariate ANOVA confirmed these Grade level differences ($\eta^2 = 35.37$, $F = 17.26$, $p < 0.000$), and differences between Grade cohorts as significant ($\eta^2 = 26.97$, $F = 13.16$, $p < 0.000$). With respect to the differences between the grades at Times 1, 2 and 3 presented in Figure 1 there was also an interaction between Grade and time ($\eta^2 = 4.29$, $F = 2.10$, $p < 0.015$).

However, the data in this study is hierarchical in nature, with the boys clustered each year within different mathematics classes and grade levels across the two campuses of the school. Some students also changed from one campus to the other during the course of the study. Hierarchical Linear Modelling (HLM5) was therefore used to take the cross-level nature of the data into account (Osborne, 2000). Table 2 presents the significant effects for TK in the HLM5 analyses for the intercepts for Grades 3, 4, 5 and 9. There is also a significant interaction effect for the time slope for Grade 6 ($\beta = 0.33$, T-ratio = 5.33, $p < 0.000$). Significant effects for the intercepts for the Grade 3, 4 and 5 cohorts for TK are presented in Table 3. There are also significant interaction effects for the time slopes for Grade 5 ($\beta = -0.37$, T-ratio = -2.46, $p < 0.056$) and Grade 7 ($\beta = 0.21$, T-ratio = 3.44, $p < 0.024$).

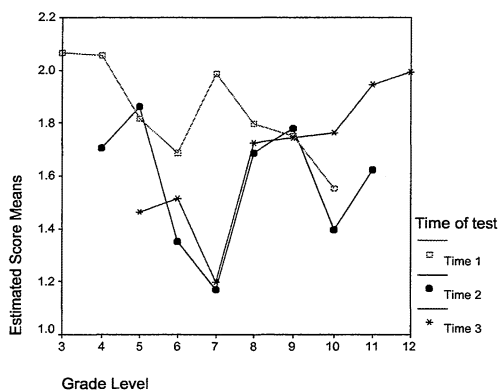


Figure 3. Ego orientation at time 1, 2 & 3.

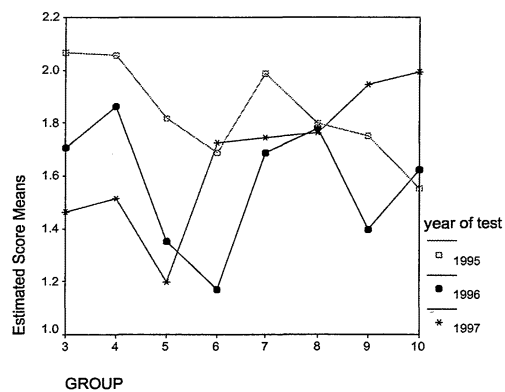


Figure 4. Ego orientation by grade cohort.

Ego Orientation

There are no significant effects in either the ANOVA or HLM analyses for EGO. However, in Figures 3 and 4 there is an overall trend for EGO to change with the introduction of co-education, with the exception of Grade 9 in Figure 3, which barely alters from T1 to T2 and T3. Analyses of the cohort effects in Figure 4 indicate a general reversal of levels of competitiveness across the school from T1 to T3. In general lower grades record higher levels of EGO at Time 1, with these levels of EGO decreasing across the school grades. In the year following co-education at T3, the lower grades reveal decreases in their levels of competitiveness, while the higher grades record corresponding rises in EGO. In Figure 4 there is an interesting decrease in EGO for Grade 6 during the transition year of T2, but this is reversed at T3 to almost the identical value recorded at T1 prior to

the introduction of co-education. However, all of these trends are not statistically significant.

Discussion

Motivation encompasses students' subjective experiences, particularly their willingness to engage in lessons and learning activities and the reasons they cite for doing so (Brophy, 1998). In this study motivation was measured directly in primary and secondary mathematics classrooms from the perspectives of boys' views of their own task or ego goal directed motivation immediately prior to, in the transitional year and in the year following the introduction of co-education to a single sex boys' school. These constructs of task involvement and ego orientation were chosen as they directly tapped boys' expressed goals for their mathematics learning during a period of significant change within their school.

Results show that there was considerable variability within and across the grades in boys' task involvement and ego orientation in mathematics in the transition from single sex education to co-education. HLM analyses of both Grade level differences at Time 1, 2 and 3 and cohort effects indicate that the transition process had a significant effect on boys' task involvement goals in the primary grades 3, 4, 5, and 6 and middle school grades 7 and 9, but not on their ego orientation. During the course of this study a number of other changes took place across the school. In the same year that co-education was introduced, Junior Primary classes from Reception to Grade 2 began on the primary school campus. A Middle School program embracing Grades 7 to 10 also commenced. Students in Grades 3 to 6 remained at the primary school campus, but the Grade 6 cohort were shifted to the Middle School which was established at the senior school campus. These moves had the effect of giving the Grade 4 cohort from Time 1 the status of being the senior students in the primary school at Time 3. However, the Grade 6 cohort from Time 1 were denied their final year in the primary school setting at Time 2 where they would have customarily enjoyed certain responsibilities and privileges as the "senior" primary students.

The trend for task involvement to decrease as students move through the grades has been reported elsewhere (Yates, 2002), particularly in relation to early adolescence (Turner, Midgley, Meyer, Gheen, Anderman, Kang & Patrick, 2002). However, these findings would suggest that conclusions from previous studies that secondary school boys fared less well in single sex contexts (Rennie & Parker, 1997; Jackson & Smith, 2000) and were advantaged in co-educational settings (Good, Nichols & Sabers, 1999) can be extended to include boys at the primary school level. Results from this study take into account the hierarchical, nested nature of the student sample, as well as particular situational and environmental variables that may be operating at the class and school levels. Previous studies of single sex and co-educational contexts have not incorporated cluster sample designs.

In comparison with the single sex classes at T1, the results indicate that the boys generally became less ego oriented in the co-educational settings at T2 and T3. The decrease in competitiveness was particularly evident in the primary school grades and in the period of early adolescence when peer relationships are paramount. Although these trends are not statistically significant, they are nevertheless interesting as they substantiate findings from a previous study in which primary and secondary students' perceptions of competitiveness decreased during and following the transition to co-education in a single sex boys' school (Yates, 2001). They also support studies of the introduction of single sex classes in mathematics within co-educational high schools (Parker & Rennie, 1995; Rennie & Parker, 1997) in which teachers perceived boys, in absence of girls, to be unruly,

disruptive, apparently unwillingly and unable to work co-operatively with each other. Teachers also observed greater co-operation in co-educational settings in high schools, with less able boys in particular more likely to request and receive help from girls (Parker & Rennie, 1995; Rennie & Parker, 1997).

The findings from the present study in relation to the reduction in competitiveness with the introduction of co-education would suggest the need for future studies to compare differences between competitive and co-operative learning in mathematics in single sex and co-educational settings at the primary school level. Differences between boys and girls' task involvement goal orientations could also be considered. The problem of the relatively small number of ego items in *Your Feelings in Mathematics: A Questionnaire* could also be addressed.

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