Student Motivation and Engagement in Mathematics, Science, and English: Multilevel Modelling

Andrew J. Martin and Herbert W. Marsh

SELF Research Centre, University of Western Sydney, Australia

Across mathematics, science, and English school subjects, the present study explores a number of issues relevant to the multilevel nature of motivation and engagement. Among a sample of 1,701 junior and middle high school students, it examines the extent to which motivation and engagement vary at student, class, and school levels. Using multilevel modelling procedures (MLwiN), findings demonstrate that the bulk of variance in motivation and engagement occurs at the student level. Relatively few measures yielded significant class-level variance and the bulk of significant class-level variance was found for mathematics. Findings are discussed in terms of the implications for educational intervention and for current thinking and theorising about student motivation and engagement.

Introduction

Over the past two decades there has been a great deal of research investigating student motivation and engagement. Most of this research is conducted on the assumption that motivation is primarily a student-level construct and does not account for the fact that there is also variation at other levels such as at the class and school levels. Following from this, it is also assumed that educational intervention aimed at enhancing motivation should be directed solely at the individual student, without adequate recognition that there may well also exist a class and school motivational climate that needs to be addressed. If such climates exist, then intervention also needs to be targeted at the class/teacher and whole-school level. It is therefore important to understand the extent to which motivation varies as a function of student, class, and school. The answer to this question holds substantial educational implications not only for more targeted intervention but also for system-level and school policy.

In terms of academic achievement, there is existing evidence that a good proportion of the variance is explained at the student and class level. For example, Rowe and colleagues (Hill & Rowe, 1998; Rowe, 2000; Rowe & Rowe, 2002) have shown that the bulk of residual variance in student achievement is explained by teacher- and classroom-related factors, around one-third of the variance is explained by student characteristics, and a small amount is explained by school-level factors. Indeed, in a major analysis of pedagogy, Lingard and Ladwig (2001) found that there were more differences in pedagogy between teachers than between schools (see also MacDonald, Saunders, & Benfield, 1999; Rowe, 2000). Qualitative work has supported similar conclusions (Martino & Meyenn, 2002).

The present study uses multilevel statistical procedures to determine the relative contribution of student, class, and school factors in students’ academic motivation and engagement. The findings hold not only pedagogical implications for practitioners and researchers but also have potential to better inform policy and debate surrounding students’ educational needs and how these can best be met.

Motivation in Different School Subjects

Previous research indicates that there are key dimensions on which motivation and engagement vary as a function of the school subject. Gottfried (1982) measured anxiety and intrinsic motivation in four school subjects (reading, math, social studies, and science) and concluded that the relationship between academic intrinsic motivation and anxiety varied according to the school subject. Smith and Fouad (1999) also confirmed the existence of different levels of self-efficacy, interest, outcome expectancies and goals for mathematics, art, social science and English subjects. Other motivational researchers (e.g., Eccles et al., 1983) have emphasised the domain specificity of
constructs such as expectancy for success (defined in terms of perceived competency, anxiety, and self-concept) and task value (defined in terms of interest, usefulness, and challenge).

Taken together, there is support for the need to examine the domain specific nature of students’ motivation and engagement. Accordingly, the present study assesses the multilevel (student, class, school) nature of motivation and engagement on these dimensions in mathematics, English, and science.

The Hierarchical Nature of Motivation and Engagement
This far, we have focused on research that is typically conducted at the level of student. In general, however, it is inappropriate to pool responses of individuals without regard to groups unless it can be shown that the groups do not differ significantly from each other. Education is a classic domain in which there exists grouped and hierarchically structured data, with the most obvious structure being students within classes within schools. Once individuals are grouped, their group becomes differentiated from other groups and this implies that its members and the group itself both influence and are influenced by the group membership (Goldstein, 2003). However, it was not until the 1990s that efficient software was developed to account for the hierarchical structure of data and research following from these software developments derived a number of findings that indicated the importance of treating data in this way.

Duda (2001) emphasised the need to evaluate the combined effects and interactions of individual motivation and motivational climate on a variety of outcome measures as well as the theoretical basis for pursuing such research. She lamented, however, that this is rarely pursued in motivational research. Duda also indicated that particularly strong climates might override the effects of individual orientations, whereas individuals with particularly strong motivation orientations are likely to be less affected by motivational climate (see also Ntoumanis & Biddle, 1998; Whitehead, Andree & Lee, 1997). Although there is a relatively more consistent line of research assessing the hierarchical nature of achievement, there is relatively little that examines the hierarchical nature of motivation and engagement and the issue of motivational climates in the academic context. The present study therefore accounts for the hierarchical structure of motivation in different school subjects.

The Present Research
Taken together, therefore, the present study explores a number of issues including (a) the extent to which motivation and engagement vary at student, class, and school levels, (b) the relative salience of each of these levels and what level accounts for most variance in motivation and engagement, (c) the implications of these findings for educational intervention aiming to enhance motivation and engagement, and (d) the implications of findings for current thinking and theorising about student motivation and engagement.

Method

Sample and Procedure
The present study focuses on Year 8 and 10 high school students in their mathematics, English, and science classes. The sample comprises 1,701 high school students in Year 8 (60%) and Year 10 (40%) from five Australian co-educational government schools. Just under half (49%) the respondents were female and 51% were male. The mean age of respondents was 14.29 (SD=1.11) years. Schools were asked to select two of three subjects (maths, English, science) in which to survey students. All schools selected mathematics, three schools selected English and two schools selected science. In total, 101 classrooms were surveyed comprising 68 mathematics classrooms, 19 science classrooms, and 14 English classrooms. Fifty-nine percent of the teachers teaching the target classes were females and 41% were males.

Teachers administered the Student Motivation and Engagement Scale (Martin, 2001, 2003) as well as a set of items capturing other educational constructs of relevance to students during class. The rating scale was first explained and a sample item presented. Students were then asked to complete the instrument on their own and to return the completed instrument to the teacher at the end of class. Importantly, students rated their motivation and engagement in a particular subject when they were seated in that actual class. Hence, they rated their mathematics motivation
and engagement in the mathematics class, their science motivation and engagement in their science class, and their English motivation and engagement in their English class.

**Materials**
The instrument comprised the Student Motivation and Engagement Scale (Martin, 2001, 2003) as well as a set of other constructs deemed to be of relevance to the breadth of students’ experience in the classroom.

**The Student Motivation and Engagement Scale**
The Student Motivation and Engagement Scale is an instrument that measures high school students’ motivation and engagement. It is hypothesised to assess motivation through three adaptive cognitive dimensions, three adaptive behavioural dimensions, three impeding cognitive dimensions, and two maladaptive behavioural dimensions of motivation and engagement. Each of the eleven factors comprises four items – hence it is a 44-item instrument. To each item, students rate themselves on a scale of 1 (‘Strongly Disagree’) to 7 (‘Strongly Agree’). Martin (2001, 2003) has shown that the Student Motivation and Engagement Scale has a sound factor structure, comprises reliable and approximately normally distributed dimensions, is significantly associated with literacy, numeracy, and achievement in Mathematics and English, and is sensitive to age- and gender-related differences in motivation.

**Adaptive dimensions of motivation and engagement**
Each adaptive dimension falls into one of two groups: cognitions and behaviours. Adaptive cognitions include self-efficacy, mastery orientation, and valuing of subject. Adaptive behaviours include persistence, planning, and study management. On each of these dimensions, students were asked to rate in relation to the school subject they were present for at the time.

- **Self-efficacy** (eg. "If I try hard, I believe I can do my schoolwork well"): Adapted in part from Midgley et al’s (1997) Patterns of Adaptive Learning Survey, self-efficacy is students’ belief and confidence in their ability to understand or to do well in their schoolwork, to meet challenges they face, and to perform to the best of their ability.

- **Valuing of subject** (eg. "Learning in this subject is important to me"): Adapted in part from Pintrich et al’s (1991) Motivated Strategies for Learning Questionnaire, valuing of a subject is how much students believe what they learn in that subject is useful, important, and relevant to them or to the world in general.

- **Mastery orientation** (eg. "I feel very pleased with myself when I really understand what I’m taught in this subject"): Adapted in part from Nicholls (1989), mastery orientation is being focused on learning, solving problems, and developing skills.

- **Planning** (eg. "Before I start an assignment I plan out how I am going to do it"): Adapted in part from Miller et al. (1996), planning is how much students plan their schoolwork, assignments, and study and how much they keep track of their progress as they are doing them.

- **Study management** (eg. “When I study, I usually study in places where I can concentrate”): Adapted in part from Pintrich et al. (1991), study management refers to the way students use their study time, organize their study timetable, and choose and arrange where they study.

- **Persistence** (eg. "If I can’t understand my schoolwork at first, I keep going over it until I understand it"): Adapted in part from Miller et al. (1996), persistence is how much students keep trying to work out an answer or to understand a problem even when that problem is difficult or is challenging.

**Impeding cognitive dimensions**
Impeding cognitive dimensions are anxiety, failure avoidance, and uncertain control. On each of these dimensions, students were asked to rate in relation to the school subject they were present for at the time.

- **Anxiety** (eg. "When exams and assignments are coming up, I worry a lot"): Adapted in part from Pintrich and DeGroot (1990), anxiety has two parts: feeling nervous and worrying. Feeling nervous is the uneasy or sick feeling students get when they think about their schoolwork, assignments, or exams. Worrying is their fear about not doing very well in their schoolwork, assignments, or exams.

- **Failure avoidance** (eg. "Often the main reason I work in this subject is because I don’t want to disappoint my parents"): Adapted from an orientation outlined by Harter, Whitesell,
Kowalski (1992), students have an avoidance focus when the main reason they do their schoolwork is to avoid doing poorly or to avoid being seen to do poorly.

**Uncertain control** (eg. "I'm often unsure how I can avoid doing poorly in this subject"): Adapted in part from Connell’s (1985) Unknown cognitive dimension of the Multidimensional Measure of Children’s Perceptions of Control (1985), this subscale assesses students’ uncertainty about how to do well or how to avoid doing poorly.

**Maladaptive behavioural dimensions**

Maladaptive behavioural dimensions are self-handicapping and disengagement. On each of these dimensions, students were asked to rate in relation to the school subject they were present for at the time.

**Self-handicapping** (eg. "I sometimes don’t study very hard before exams so I have an excuse if I don’t do as well as I hoped"): Adapted from the Academic Self-Handicapping Scale (Midgley, Arunkumar, & Urdan, 1996) and the Shortened Self-handicapping Scale (Strube, 1986), students self handicap when they do things that reduce their chances of success at school. Examples are putting off doing an assignment or wasting time while they are meant to be doing their schoolwork or studying for an exam.

**Disengagement** (eg. "I often feel like giving up in this subject"): Students are disengaged or at risk of disengagement when they feel like giving up in particular school subjects. Students high in disengagement tend to accept failure and behave in ways that reflect helplessness.

**Other Educational Constructs**

In order to conduct a more expansive analysis of the issues under focus, it was also of interest to explore the nature of effects on some other conceptually relevant educational constructs. To this end, the sample was also administered items that explored their enjoyment of the subject (e.g., “I enjoy this subject”), class participation (e.g., “I get involved in things we do in class”), educational aspirations (e.g., “I’d like to continue studying or training in this subject after I complete school”), teacher-student relationships (e.g., “I get along well with my teacher”), and academic resilience (e.g., “I think I’m good at dealing with schoolwork pressures”). Psychometric properties of these scales are presented below.

**Statistical Analysis**

Data analysis essentially involved two procedures: confirmatory factor analysis (CFA) and multilevel modelling. In the first instance, CFA was conducted to explore the psychometric properties of the instrument under focus. Having established the psychometrics, the analysis progressed to an assessment of variance as a function of student, class, and school level factors.

**Confirmatory Factor Analysis**

Confirmatory factor analysis (CFA), performed with LISREL version 8.54 (Joreskog & Sorbom, 2003), is the primary method used to test the psychometric properties of the Student Motivation and Engagement Scale and the other educational constructs. In CFA, the researcher posits an *a priori* structure and tests the ability of a solution based on this structure to fit the data by demonstrating that (a) the solution is well defined, (b) parameter estimates are consistent with theory and *a priori* predictions, and (c) the $\chi^2$ and subjective indices of fit are reasonable (Marsh, Balla & McDonald, 1988; McDonald & Marsh, 1990). Maximum likelihood was the method of estimation used for the models. In evaluating goodness of fit of alternative models, the root mean square error of approximation (RMSEA) is emphasized. Although the RMSEA is apparently the most widely endorsed criterion of fit, also presented are the non-normed fit index (NNFI), the comparative fit index (CFI), the $\chi^2$ test statistic, and an evaluation of parameter estimates.

For RMSEAs, values at or less than .08 and .05 are taken to reflect an acceptably close fit and an excellent fit respectively (see Joreskog & Sorbom, 1993; Marsh, Balla & Hau, 1996; Schumacker & Lomax, 1996). The NNFI and CFI vary along a 0-to-1 continuum in which values at or greater than .90 and .95 are typically taken to reflect acceptable and excellent fits to the data respectively (McDonald & Marsh, 1990). The CFI contains no penalty for a lack of parsimony so that improved fit due to the introduction of additional parameters may reflect capitalization on chance, whereas the NNFI and RMSEA contain penalties for a lack of parsimony. Whereas tests of statistical significance and indices of fit aid in the evaluation of the fit, there is ultimately a degree of subjectivity and professional judgment in the selection of a ‘best’ model.
A growing body of research has emphasised potential problems with traditional pairwise, listwise, and mean substitution approaches to missing data (e.g., Brown, 1994; Graham & Hoffner, 2000; Little & Rubin, 1987), leading to the implementation of the Expectation Maximization Algorithm, the most widely recommended approach to imputation for missing data, as operationalised using missing value analysis in LISREL. The EM Algorithm was used to handle missing data within a given subject, but not across subjects. Hence, for example, in terms of the sample that completed the Science form, the EM Algorithm was used to address missing data to yield no missing data within Science.

**Multilevel Modelling**

Multilevel modelling (also known as hierarchical linear modelling) has emerged over the past decade as a highly flexible and useful approach to analysing hierarchically structured data (Goldstein, 2003; Kreft & De Leeuw, 1998; Snijders & Bosker, 1999). This technique is advantageous over traditional statistical procedures because it allows researchers to simultaneously consider multiple units within the same analysis, as well as avoid the problems related to dependence, aggregation bias and unbalanced data structures (e.g., Goldstein, 2003; Hox, 1995, 1998; Raudenbush & Chan, 1993; Snijders & Bosker, 1999). For the present investigation, the data were conceptualised as a three-level model, consisting of student at the first level, class at the second level, and school at the third level. The multilevel analyses were conducted using MLwiN version 2.00 (Rasbash et al., 2004). In the present data analyses, a baseline variance components model (Rasbash et al., 2004) or intercept-only model (Hox, 1995) was used to evaluate how much variation in each of the outcome measures could be attributed to the school (level 3), the class (level 2) and the student (level 1).

**Estimation Procedure and Significance of Parameters**

Iterative generalised least squares (IGLS) was the procedure used to estimate the fixed and random parameters of all multilevel models. IGLS is the default method of estimation in MLwiN and is based on iterative procedures. This method finds point estimates for the unknown parameters of interest in the model. The process involves iteratively estimating the parameters for all parameters do not change from one cycle to the next and, hence, convergence has been achieved (see Goldstein, 2003 for detailed review of the IGLS procedure).

Given the large number of statistical tests involved, the $p$ value was conservatively set at 0.01 to reduce Type I error. The statistical significance of fixed parameters was evaluated using the Wald statistic (Hox, 1995), which examines the ratio of a parameter estimate to its standard error. For a large random sample, the ratio of a fixed parameter to its standard error is approximately normally distributed with mean 0 and variance 1. The ratio of the parameter estimate to its standard error gives the critical $t$ value to test the significance of the parameter estimate. If this ratio is greater than 2.58 (the critical value under normal distribution for $p<0.01$) the parameter estimate is significantly different from zero (Hox, 1995; Quené & Bergh, 2002).

**Results**

**Psychometric Properties of the Measures**

Before conducting the central multilevel analyses, it was first important to establish the psychometric properties of the instrument used. This comprised a 16-factor CFA for each of the three school subjects based on the 44-item Student Motivation and Engagement Scale items and the additional 20 items assessing each of the five additional educational constructs (enjoyment of subject, class participation, academic resilience, teacher-student relationship, and educational aspirations). For mathematics, the CFA yielded an excellent fit to the data ($\chi^2=7458.64$, df=1832, NNFI=.97, CFI=.97, RMSEA=.047) as it did for science ($\chi^2=5645.56$, df=1832, NNFI=.96, CFI=.97, RMSEA=.052), and English ($\chi^2=5208.75$, df=1832, NNFI=.97, CFI=.97, RMSEA=.050). Factor loadings are presented in Table 1. Taken together, the loadings are acceptable. Reliabilities (Cronbach’s alpha) for each scale in each subject are presented in Table 1 as well. These data show that each scale can be considered reliable.
Table 1
Factor Loadings and Reliabilities for the Student Motivation and Engagement Scale and Other Educational Measures (Maths/Science/English)

<table>
<thead>
<tr>
<th></th>
<th>Item 1 Mth/Sc/Eng</th>
<th>Item 2 Mth/Sc/Eng</th>
<th>Item 3 Mth/Sc/Eng</th>
<th>Item 4 Mth/Sc/Eng</th>
<th>Reliability Mth/Sc/Eng</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Student Motivation and Engagement Scale Factors</strong></td>
<td></td>
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<tr>
<td>Self-efficacy</td>
<td>69/70/77</td>
<td>70/65/73</td>
<td>65/65/67</td>
<td>74/72/73</td>
<td>77/76/81</td>
</tr>
<tr>
<td>Mastery orientation</td>
<td>68/68/72</td>
<td>72/77/72</td>
<td>76/76/73</td>
<td>81/77/77</td>
<td>81/82/82</td>
</tr>
<tr>
<td>Valuing of subject</td>
<td>57/58/69</td>
<td>75/74/72</td>
<td>74/68/77</td>
<td>68/67/71</td>
<td>76/75/81</td>
</tr>
<tr>
<td>Planning</td>
<td>66/61/71</td>
<td>77/75/81</td>
<td>77/82/77</td>
<td>45/44/46</td>
<td>74/77/73</td>
</tr>
<tr>
<td>Study management</td>
<td>69/71/76</td>
<td>70/73/73</td>
<td>83/85/80</td>
<td>72/74/75</td>
<td>82/84/84</td>
</tr>
<tr>
<td>Persistence</td>
<td>61/65/66</td>
<td>72/75/78</td>
<td>73/74/80</td>
<td>77/77/80</td>
<td>80/81/84</td>
</tr>
<tr>
<td>Anxiety</td>
<td>75/79/82</td>
<td>69/74/69</td>
<td>55/66/60</td>
<td>70/65/69</td>
<td>77/80/79</td>
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<td>Failure avoidance</td>
<td>80/80/84</td>
<td>82/84/80</td>
<td>47/56/61</td>
<td>61/67/65</td>
<td>76/80/81</td>
</tr>
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<td>Uncertain control</td>
<td>64/60/63</td>
<td>67/65/73</td>
<td>75/71/74</td>
<td>73/76/73</td>
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<td>Self-handicapping</td>
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<td>Disengagement</td>
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<td>72/69/77</td>
<td>71/65/73</td>
<td>79/77/77</td>
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<td><strong>Other Educational Factors</strong></td>
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<td>Educational aspirations</td>
<td>84/88/83</td>
<td>85/91/86</td>
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<td>64/76/65</td>
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<td>Enjoyment of subject</td>
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<td>85/88/84</td>
<td>67/57/69</td>
<td>79/81/79</td>
<td>84/83/86</td>
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<td>Academic resilience</td>
<td>67/71/68</td>
<td>69/73/74</td>
<td>71/74/73</td>
<td>68/72/77</td>
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<td>Teacher-student relationship</td>
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<td>78/80/73</td>
<td>80/83/78</td>
<td>89/90/88</td>
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</table>

*Note: Coefficient order as follows: Maths/Science/English. Decimals omitted*
The Variance Components Model

Having established the psychometric properties of the instrument, data analysis moved on to the issues under focus. This involved an assessment of the relative contribution of student-, class-, and school-level variance to the 16 motivation and engagement measures. The variance components model tests for such effects and this is conducted in MLwiN. The 16 measures were computed by aggregating the 4 items for each factor and then standardizing (M=0, SD=1) this score within each school subject. Findings for each school subject are presented in Table 2. This table displays unstandardised parameters estimates and the standard error. An * is presented when the parameter is statistically significant at \( p<0.01 \).

Clearly, for all school subjects and for all measures, the bulk of variance is accounted for at the student level. That is, there is greater variation from student to student than there is from class to class or school to school. On some of the measures in mathematics and science there is significant class-level variance. For maths, there is significant class-level variation on mastery orientation, self-handicapping, disengagement, enjoyment of the subject, educational aspirations, and teacher-student relationship. For science, there is significant class-level variation in teacher-student relationship only. For English, there is no significant class-level variation. Perhaps not surprisingly, where there is class-level variation it appears to be greatest on the measure of teacher-student relationship which was the only factor on which there was relatively more substantial variation in terms of parameter estimates (e.g., explaining up to a third of the variance for science) and for which there was a significant effect in more than one subject.

Summary of Findings across School Subjects

A summary of all significant findings as a function of school subject is also presented in Table 2. There was significant student-level variance for all subjects on all measures. That is, of the 48 tests (16 measures x 3 subjects) conducted of student-level variance, all yielded significant results. On six of the 16 measures, there was significant class-level variance for mathematics; this was the case for only one of the science measures and none of the English measures. Hence, class effects are greatest for mathematics. Teacher-student relationships was the only factor for which there was class-level variance on more than one subject. Taken as a whole, across 48 tests of class-level variance, there was significant variance in only seven (1.5%) of the tests. Of the 48 tests of school-level variance, none were significant.

Discussion

The present study aimed to examine across mathematics, science, and English subjects student-, class-, and school-level variance in a set of psychometrically sound and reliable motivation and engagement constructs. Finding showed that the bulk of variance is accounted for at the student level and on a relatively small set of constructs there was significant variance at the class level. No significant variance was explained at the school level.

Significance of Findings

A key finding is that the bulk of variance in motivation and engagement occurs at the student level. Where there was relatively more class-level variance the construct related more explicitly to class and teacher factors such as teacher-student relationships where up to a third of the variance was explained at the class level. Hence, on the more mentalistic or intrapsychic dimensions there exists more variance at the student level and as the construct involves factors external to the individual, the context plays more of a role. This finding holds implications for educational intervention. It suggests that student-level intervention rather than whole-class or whole-school intervention on motivation and engagement will yield the best results.

Indeed, recent attention has been given to the importance of pursuing use-inspired basic research (Pintrich, 2003; Stokes, 1997). It is significant that the present study provides greater direction for specific intervention and practice aimed at enhancing students’ motivation: by addressing 16 dimensions of students’ academic motivation and engagement, the study has identified key dimensions which vary at student and class levels. It follows that intervention or support can be developed for students determined by findings pertaining to the specific adaptive,
### Table 2

**Parameters Estimates and Standard Errors for Variance Components Models**

<table>
<thead>
<tr>
<th></th>
<th>Math</th>
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</tr>
<tr>
<td>Disengagement</td>
<td>942(044)*</td>
<td>057(022)*</td>
<td>000(000)</td>
<td>902(065)*</td>
</tr>
<tr>
<td><strong>Other Educational Factors</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class participation</td>
<td>972(046)*</td>
<td>026(016)</td>
<td>000(000)</td>
<td>928(067)*</td>
</tr>
<tr>
<td>Enjoy subject</td>
<td>916(043)*</td>
<td>082(026)*</td>
<td>000(000)</td>
<td>853(062)*</td>
</tr>
<tr>
<td>Ed aspirations</td>
<td>918(043)*</td>
<td>080(026)*</td>
<td>000(000)</td>
<td>863(063)*</td>
</tr>
<tr>
<td>Tch-student r’ship</td>
<td>788(037)*</td>
<td>206(049)*</td>
<td>000(000)</td>
<td>675(049)*</td>
</tr>
<tr>
<td>Academic resilience</td>
<td>969(045)*</td>
<td>024(016)</td>
<td>006(009)</td>
<td>979(071)*</td>
</tr>
</tbody>
</table>

* p<0.01; Decimals omitted; Multilevel components of analyses are shaded
impeding and maladaptive dimensions of motivation and engagement assessed in the present study. Indeed, such targeted intervention is likely to be more effective than more global and undifferentiated intervention (Weisz, Weiss, Han, Granger & Morton, 1995).

Another noteworthy finding emerging from the study related to the differential extent to which class-level variance emerged in each school subject. Specifically, the greatest class-level variance occurred for mathematics and very little emerged for science and English. That is, motivation and engagement vary markedly more from class to class for mathematics than for the other two subjects. It seems that for mathematics in particular, good and poor quality teaching can yield their greatest impacts. This may be the case because mathematics is typically a subject students are more likely to struggle with compared to other subjects. For example, previous research has found that students experience a decline in valuing of mathematics after the junior high transition, whereas their valuing of English increases (Eccles et al., 1983; Wigfield, Eccles, Maclver, Reuman & Midgley, 1991). Other research finds relatively higher levels of anxiety associated with mathematics (Bessant, 1995; Pajares & Urdan, 1996). Also, relative to science and English, mathematics may be considered by students to be among the drier of the subjects. Taken together, lower levels of valuing, higher levels of anxiety, and potentially drier content suggest that mathematics may be the subject in which quality teaching is most needed.

The findings also show that there is merit in conducting research and intervention that is specific to a given school subject. Global efforts to enhance academic motivation, engagement, class participation, enjoyment of school, and educational aspirations may not be as effective as intervention directly targeting motivation and engagement in particular school subjects. Indeed, the present study employed a unique methodology to fully capture the domain specific dimension of students’ motivation and engagement; one in which students rated the subject (mathematics, science or English) within the actual class to which the ratings pertained. Given previous suggestions that classroom context may influence a student’s response to questions about motivation and engagement (Pintrich & DeGroot, 1990), if class-level variance would ever to come to the fore, it is likely to be using this methodology in which the actual experience of contextual factors is immediately present and top-of-mind. The fact that it emerged markedly more saliently for mathematics than science or English underpins the utility of pursuing domain specific research.

Limitations and Future Directions
The present study provides much information on the role of student, class, and school-level variance in explaining motivation and engagement in three core school subjects. There are, however, a number of potential limitations important to consider when interpreting findings and which provide some direction for further research.

The data presented in this study are all self-reported. Although this is a logical and defensible methodology in its own right given the substantive focus, it is important to conduct research that examines the same constructs using data derived from additional sources. Further on this issue of data collection, it is important to recognise that the data were collected at the one time point and so future longitudinal work is needed to explore the stability of constructs over time and to provide greater scope to partial out residual variance that in this study was manifested in student-level variance.

There is also a need to comment on the statistical significance of findings. Given the large number of statistical tests conducted, a more conservative p-value was set (p<0.01) to reduce the chances of Type I error. This excluded some findings significant at the 0.05 level. If information regarding these exclusions are of interest, the reader is urged to consult the results where the ratio of the parameter estimate to its standard error gives the critical t value to test the significance of the parameter estimate.

Finally, academic achievement was not included in the present study. Most multilevel literature focusing on student, class, and school variance includes academic achievement. Because relatively less motivation and engagement research has focused on multilevel issues, it was deemed appropriate to only focus on these in the present study. However, the inclusion of achievement as a desirable educational outcome is important for future research.
Conclusion
The present study used multilevel statistical procedures to determine the relative salience of student, class, and school variance in students’ academic motivation and engagement. Findings demonstrated that the bulk of variance in motivation and engagement occurs at the student level. Relatively few measures yielded significant class-level variance and the bulk of significant class-level variance was found for mathematics. Taken together, the findings of the present investigation hold substantive and methodological implications for researchers studying issues relevant to motivation and engagement and are also relevant to educators seeking to enhance educational outcomes that rely in large part on the extent to which their students are affectively, cognitively, and behaviourally engaged.

About the Authors
Dr Andrew Martin is Postdoctoral Research Fellow at the SELF Research Centre, University of Western Sydney. He is a Registered Psychologist and his research interests are student motivation, parenting, and research methodology. In 2002, his PhD was judged the Most Outstanding Doctoral Dissertation in Educational Psychology by the American Psychological Association and before that was judged the Most Outstanding PhD in Education in Australia by the Australian Association for Research in Education. Andrew was also listed in The Bulletin’s SMART 100 Australians and in the Top 10 in the field of Education. He has published over 35 refereed articles and chapters and presented 18 invited/keynote addresses in the past two years. Andrew also regularly conducts staff development in schools focused on enhancing student motivation in the classroom, and is author of the recently published book by Bantam, “How to Motivate Your Child For School and Beyond”.

Herb Marsh is Professor of Educational Psychology, University of Western Sydney, and founding Director of the Self-concept Enhancement and Learning Facilitation (SELF) Research Centre that has a large international membership. He is the author of internationally recognised psychological tests (self-concept, motivation, university students' evaluations of teaching effectiveness) and has published more than 230 articles, 22 chapters, 8 monographs, and 225 conference papers. Professor Marsh is the most frequently cited Australian educational researcher and has been recognized as one of the most productive educational psychologist in the world, as one of the top 10 international researchers in Higher Education and in Social Psychology, and the 11th most productive researcher across all disciplines of psychology.

Contact Details
Dr Andrew Martin
Postdoctoral Research Fellow
SELF Research Centre
University of Western Sydney
Bankstown Campus, Penrith South NSW 1797 Australia
Email: a.martin@uws.edu.au
Phone: (02) 9772 6656 (or + 61 2 9772 6656)
Fax: (02) 9772 6432 (or + 61 2 9772 6432)

Professor Herb Marsh
Director, SELF Research Centre
University of Western Sydney
Bankstown Campus, Penrith South NSW 1797 Australia
Email: h.marsh@uws.edu.au
Phone: (02) 9772 6633 (or + 61 2 9772 6633)
Fax: (02) 9772 6432 (or + 61 2 9772 6432)
References


