



## Real-time motivation and engagement during a month at school: Every moment of every day for every student matters<sup>☆</sup>



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### ARTICLE INFO

#### Article history:

Received 12 July 2014

Received in revised form 20 November 2014

Accepted 22 January 2015

Available online xxxx

#### Keywords:

Motivation

Engagement

Real-time

Multilevel

Longitudinal

Experience sampling

### ABSTRACT

This study collected intensive intra-individual real-time longitudinal motivation and engagement data using mobile electronic devices for one month. A four-level model consisted of within-day ratings at the first level (3 ratings per day), between-day ratings at the second level (5 days per week), between-week ratings at the third level (4 weeks), and between-student ratings at the fourth level (60 possible time points per student). After controlling for socio-demographics and prior achievement, multilevel modeling showed substantial within-day (intra-individual) variability in motivation and engagement ( $M = 23\%$ ) and substantial between-student variability ( $M = 67\%$ ). There was not so much variability between days ( $M = 3\%$ ) – and not so much between weeks ( $M = 6\%$ ). Linear and non-linear (quadratic) effects through the day, week, and month were predominantly non-significant. It is concluded that for optimal motivation and engagement to occur and be sustained, every moment of every day for every student matters.

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### 1. Introduction

What is the pattern of student motivation and engagement over the course of a day, a week or a month at school? Is there more or less variation in motivation and engagement within a day than between days and weeks? How do patterns of variation for motivation and engagement within and across days and weeks compare with patterns of variation for non-academic factors (e.g., self-esteem, life satisfaction)? Are there particular points in a day, week or month where educational practice is best directed to enhance student motivation and engagement? What conceptual, operational and methodological lessons can be learnt from 'real-time' intensive longitudinal motivation and engagement research? In this study, we address these questions using mobile technology to collect intensive real-time multidimensional motivation and engagement data, with three data collections per day, every school day, across four school weeks. Whereas the bulk of quantitative motivation and engagement research is typically focused on large samples at one point in time, the present study inverts this approach through its focus on intensive intra-day assessment.

While studies in personality and psychiatry have for some time focused on intra-individual variability such as in mood (e.g., Eid & Diener, 1999) and emotions (e.g., Trull et al., 2008), psycho-educational researchers tend to know less about intra-individual ebbs and flows of engagement and motivation. Indeed, knowledge about motivation and engagement variation within and between days would enhance our knowledge on important constructs in educational psychology. Empirical attention to intra-individual variability follows Cattell's (1952) early calls for focus on occasions within persons and Molenaar's (2004) more recent calls to return the focus to the individual in psychology. Similar to the approach of investigating (in)stability of personality traits from day to day (Hamaker, Nesselrode, & Molenaar, 2007), we investigated the within daily and between daily patterns of motivation and engagement factors. In our ecological momentary assessment study we have uniquely collected an average of 38 longitudinal responses from each of 20 case studies of high school students.

### 2. Theoretical perspectives on intra- and inter-individual educational phenomena

#### 2.1. Child development and transactional approaches

Following Vygotsky (1978), there has been substantial recognition of the interaction and reciprocity between individual and environment that undergirds the importance of examining how an individual may

<sup>☆</sup> The authors would like to thank the Australian Research Council and the Australian Boarding School Association for funding this research (ARC Linkage Grant #LP0990853).

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vary from situation to situation and context to context. Subsequently, contemporary theories of child development have recognized the interplay of individual and environment and with some recognition of multilevel (situated) considerations that can explore intra-individual variability (Shonkoff & Phillips, 2000). Thus, “no two children share the same environment, and no environment is experienced in exactly the same way by two different children” (Shonkoff & Phillips, 2000, p. 24). That is, although sharing the same educational environment, each student experiences a distinct reality that gives rise to the need to look closely at student factors that are relevant to educational development. Furthermore, because environment does interact with the individual to shape responses, there is likely to be intra-individual variability that responds to the different stimuli occurring in every school day.

The transactional model also emphasizes the dynamic interplay between individual and environment shaping intra-individual changes over time (Sameroff, 2009). The transactional model has intra- and inter-individual heterogeneity as a foundation, with individual development seen in terms of a set of possibilities depending on how the individual and the environment dynamically transact. Indeed, because of the dynamic transactions between the individual and environment, “the transactional model emphasizes discontinuities” (Sameroff, 2009, p. 17) – a hallmark of intra- and inter-individual variance and heterogeneity. Thus, transactional approaches are founded on inherent heterogeneity that is a function of the dynamic interplay of person and environment. Through individual differences in psycho-educational phenomena and in the way the academic environment is received and experienced by the individual, there is a transactional rationale for predicting intra- and inter-student variation in motivation and engagement.

Transactional emphases on heterogeneity, levels of phenomena, and the dynamic interplay between individual and environment have also led some to suggest that multilevel modeling is an ideal data analytic approach to test transactional contentions (Gonzalez, 2009). Whereas ‘traditional’ analytic techniques focus on group-level variance and seek to control for individual-level variance, more cutting-edge multivariate approaches (such as multilevel modeling) explicitly model individual-level variance because assumptions about group homogeneity are substantively and empirically unsustainable: “One freeing aspect of modern statistics is that it is no longer necessary to make simplifying assumptions that all participants within a treatment group are the same or respond to treatment in the same way ... this is the major benefit that random-effects [multilevel] models offer – they allow one to model heterogeneity” (Gonzalez, 2009, p. 231). We extend this concept even further by exploring the extent to which there is also intra-individual (i.e., momentary experiences nested under the individual) heterogeneity that might have implications for educational research and practice.

## 2.2. Ecological perspectives

Ecological perspectives emphasize the unique processing of and interaction with the environment by each individual and the inherent intra- and inter-individual factors and processes at play in this interaction (Bronfenbrenner, 1979, 1992, 2001). According to Bronfenbrenner, a key principle of the ecological approach is that “the scientifically relevant features of any environment for human development include not only its objective properties but also the way in which these properties are subjectively experienced by the persons living in that environment ... very few of the external influences significantly affecting human behavior and development can be described solely in terms of objective physical conditions and events” (Bronfenbrenner, 2001, p. 6964). Bronfenbrenner (1979, 1992, 2001) further proposed a model of human development that has the child (and intra-child attributes) at the center of a system comprising the microsystem, then mesosystem, then exosystem, then macrosystem, and then the more recently proposed chronosystem (the passage of time). The ecological levels described under Bronfenbrenner’s model are useful for thinking about

the possible levels (intra-student or otherwise) that may be sources of influence for motivation and engagement.

Given our investigation is essentially focused on student cases, it is the lower levels of students’ ecologies that are of central interest. Thus, we do not attend to or test the upper structural levels of Bronfenbrenner’s framework. Of relevance to this, it is notable that Bronfenbrenner and Morris (2006) identified the inner (‘lower’) layers of the ecological system as being particularly influential on development; relative to the more distal ecologies, the moment-to-moment interactions were deemed particularly salient for development. It is these intra- and inter-day interactions that are the basis of the present study that explores variation in motivation and engagement multiple times in a school day. The passage of time (chronosystem) tends to be seen from a broader developmental perspective (over years, for example) such that the lower order systems operate across time, reflecting human development. Nevertheless, it may also be the case that intra-day and day-to-day time passages are also influential. Indeed, this too is a focus of the present study.

In sum, although we do not apply Bronfenbrenner’s complete framework, we do use it as a guiding approach to considering intra- and inter-individual factors in the academic domain. We also make the point that Bronfenbrenner’s approach was not formally framed in terms of the interactive, dynamic, and highly differentiated nature of the educational ecology. Here we turn to sociocultural approaches in education that more directly address this intra- and inter-individual momentary academic variation that our study seeks to examine.

## 2.3. Sociocultural approaches

Sociocultural researchers study the internalization of social phenomena (Nolen & Ward, 2008). They see the origins of psycho-educational factors such as motivation and engagement as social, but the outcome or expression of these psycho-educational factors as individual. Thus, the same environment will evoke different motivational and engagement expression (McCaslin, 2004; Walker, 2010; Walker, Pressick-Kilborn, Arnold, & Sainsbury, 2004). According to Walker, motivation and engagement may be conceptualized as social in nature and can also be internalized as an individual process (Walker, 2010). Turner and colleagues (Turner, 2001; Turner & Patrick, 2004) also talk about how constraints and opportunities provided by context impact students’ experience and the expression of motivation and engagement. Sociocultural approaches, then, quite explicitly argue for the salience of the individual experience in a shared environment. From a sociocultural perspective, psycho-educational factors are very much processed through the perspective and orientation of the student. Particularly for research that seeks to investigate intra- and inter-student motivation and engagement, a sociocultural perspective would predict substantial variance within and across days as different events impact students and also substantial variance between students as students perceive and process these events in idiosyncratic ways.

## 3. Methodological perspectives on intra-individual educational phenomena

### 3.1. Real-time data and mobile technology

In order to facilitate research on motivation and engagement as it unfolds in real time in real world settings, valid and reliable instrumentation is needed. Technical innovation enables the use of expedient and participant-friendly data collection methods (e.g., via Personal Digital Assistants, PDAs; iPads; iPods) and commercially available software (e.g., SurveyMonkey) enables ready and adaptive administration of items to which participants respond. In questionnaire studies, responses are subject to retrospection bias (Beal & Weiss, 2003; Clark & Teasdale, 1982; Robinson & Clore, 2002; Stone & Shiffman, 2002) such that individuals’ retrospections of their states, experiences, and behaviors are not always reliable depictions of their true history. Thus, delays

between events and their reporting leave data open to distortion. In order to overcome retrospection bias several research techniques have been developed, including diary studies (Bolger, Davis, & Rafaeli, 2003), experience sampling (Hektner, Schmidt, & Csikszentmihaly, 2007), ecological momentary assessment (Carson, Weiss, & Templin, 2010), contextual activity sampling (Tolvanen et al., 2011), and the investigation of micro-interactions (Guryan, Jacob, Eric Klopfer, & Groff, 2008). The resulting data that are collected, consisting of multiple records or time-reports for each participant, are referred to as intensive longitudinal data (Walls & Schafer, 2006). According to Walls and Schafer (2006), intensive longitudinal studies “uniquely contribute to our understanding of behavior and other phenomena by providing temporal information on proximal states and contexts and by providing data on ephemeral events that are difficult to recall or that are subject to other forms of reporting bias” (p. 4).

### 3.2. Multilevel modeling

Structured appropriately, these real-time data can be analyzed using multilevel modeling. A multilevel approach to intensive longitudinal data allows researchers to pursue new questions about how effects vary within the school day, between school days, between school weeks, and between students. This is particularly important in studies where a given phenomenon may be associated with both intra- and inter-individual levels (Walls & Schafer, 2006). Hence, the multilevel approach provides a much richer and more appropriate approach to evaluating psycho-educational and other educational data than would be possible with traditional single-level approaches that ignore the clustering of individuals within groups (for further discussion, see Goldstein, 2003; Marsh, Martin, & Cheng, 2008; Muthén & Muthén, 2012; Rasbash, Steele, Browne, & Prosser, 2010; Raudenbush & Bryk, 2002). Multilevel analysis in this way enables us to more closely consider intra-individual variation in motivation and engagement.

### 3.3. Linear and non-linear effects

Some research has identified the timing and scheduling of learning, lessons, and breaks within and between days as potentially influential on student processes and outcomes. Pelligrini and Dupuis (2010), for example, identify the length and timing of lessons and breaks as influencing attention in the classroom. Research into the effects of teacher immediacy within the lesson on student motivation finds linear effects, with high immediacy associated with enhanced outcomes (Christensen & Menzel, 1998), interactive effects such that immediacy combined with caring (for example) positively impacts outcomes (Comadena, Hunt, & Simonds, 2007), or variation in immediacy effects from student to student (Frymier, 1993). Another line of research examines school scheduling of lessons and curriculum. Scheduling can be conducted within the day (e.g., 4 × 4 block) or across school days (e.g., ‘alternating plan’). Lessons can be scheduled as a function of blocks or periods. Timetables can run across 5 to 10 school days. School calendars may run across the traditional 9-months of the school year or run on a ‘year-round’ basis. Indeed, the nature of timing and scheduling may affect the linear or non-linear pattern of motivation and engagement. For example, a linear weekly pattern may be more evident in a 5-day schedule that is ‘book-ended’ by a weekend than, for example, a 7-day schedule that is ‘disrupted’ by a weekend. The present study is thus also an opportunity to explore these issues with respect to motivation and engagement.

## 4. Measurement of intra-individual educational phenomena

### 4.1. Multidimensional motivation and engagement

For the purposes of the present study, motivation is defined as individuals’ inclination, energy and drive to learn, work effectively and achieve to their potential, and engagement as the behaviors aligned

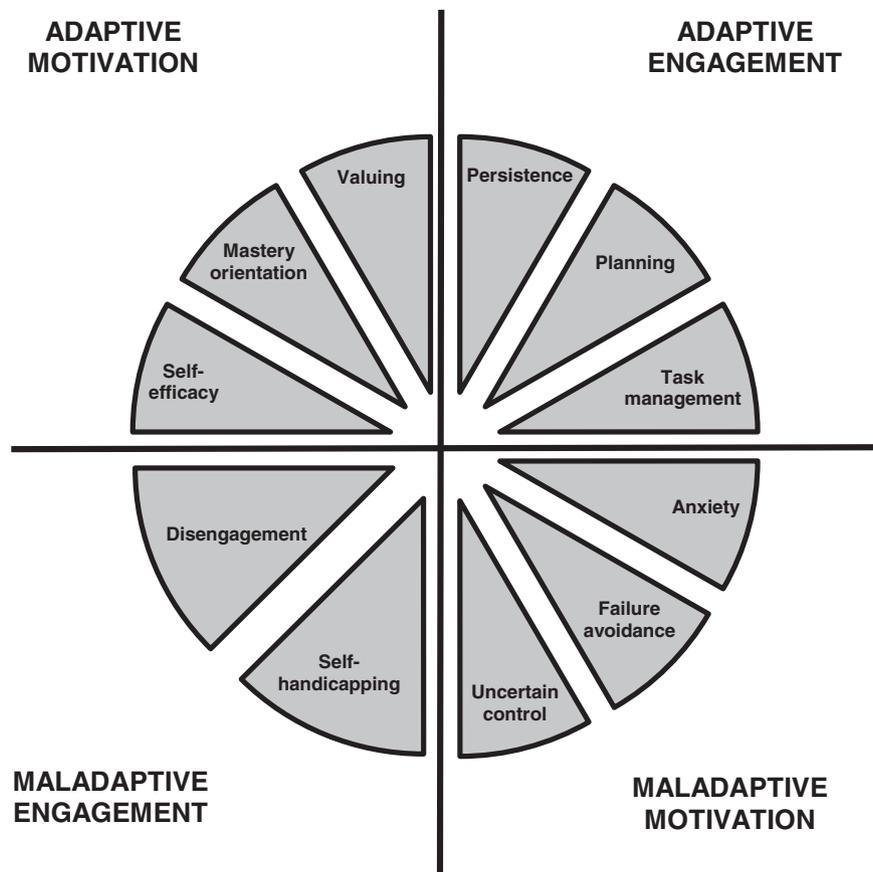
with this energy and drive (Liem & Martin, 2012; Martin, 2007, 2009). In stating this, however, we recognize other definitions and perspectives exist and are feasible. For example, although we focus on engagement in terms of behavior, tripartite perspectives that conceptualize and operationalize engagement in terms of cognition, emotion, and behavior (e.g., Fredricks, Blumenfeld, & Paris, 2004) are influential. Also, it is recognized that there are some notable examples of models reflecting diverse motivation- and engagement-related dimensions (e.g., see Midgley et al., 1997 for PALS and Pintrich, Smith, Garcia, & McKeachie, 1991 for MSLQ). Based on our definition – and ongoing calls for integrative approaches to motivation and engagement research and theorizing (Murphy & Alexander, 2000; Wigfield & Cambria, 2010) – we adopt the multidimensional Motivation and Engagement Wheel (see Fig. 1) as a framework representing salient cognition and behavior pertinent to motivation and engagement. The Motivation and Engagement Wheel is aligned with thinking proposed by Pintrich (2003) who identified seven conceptual areas for integrative motivational science, as follows: self-efficacy, attributions, valuing, control, self-determination, goal orientation, need achievement, self-regulation, and self-worth.

Accordingly, (a) self-efficacy theory (e.g., Bandura, 1997) is reflected in the self-efficacy dimension of the Wheel, (b) attributions and control are reflected in the uncertain control dimension (tapping the controllability element of attributions – see Connell, 1985; Weiner, 2010), (c) valuing (e.g., Wigfield & Eccles, 2000) is reflected in a valuing dimension, (d) self-determination (in terms of intrinsic motivation – see Ryan & Deci, 2010) and goal orientation (see Elliot, 2005) are reflected in a mastery orientation dimension, (e) self-regulation (e.g., Zimmerman, 2002) is reflected in planning, task management, and persistence dimensions, and (f) need achievement and self-worth (see Covington, 1992) are reflected in failure avoidance, anxiety, self-handicapping, and disengagement dimensions.

Although there is ongoing debate as to what constitutes motivation and what constitutes engagement (see Reschly & Christenson, 2012 for a review), there is some convergence on the view that motivation represents inner phenomena such as cognition and engagement represents outer or observable phenomena such as behavior (Martin, 2012). Accordingly, the Wheel can also be considered in terms of higher order motivation and engagement factors (specifically, four higher order factors, subsumed by eleven first order factors): adaptive motivation (self-efficacy, valuing, mastery orientation; sometimes elsewhere referred to as adaptive cognition), adaptive engagement (planning, task management, persistence; sometimes elsewhere referred to as adaptive behavior), maladaptive motivation (anxiety, failure avoidance, uncertain control; sometimes elsewhere referred to as maladaptive or impeding cognition), and maladaptive engagement (disengagement, self-handicapping; sometimes elsewhere referred to as maladaptive behavior). The Motivation and Engagement Scale (MES; Martin, 2011) is used to assess the motivation and engagement factors in the Motivation and Engagement Wheel and is the measurement tool in this study (validity and reliability details are presented in the Method section).

### 4.2. Juxtaposing motivation and engagement with non-academic measures

Consistent with recommendations around convergent and discriminant validity (John & Benet-Martinez, 2000), we propose that there should be a different pattern of variance between academic and non-academic measures. The present study includes three non-academic measures: general self-esteem, life satisfaction, and sense of meaning and purpose. Whereas motivation and engagement reflect domain-specific academically-based well-being, these constructs reflect domain-general non-academic measures of well-being. Indeed, these factors have been found to represent useful points of discrimination from academic outcomes in previous research (Martin, Nejad, Colmar, & Liem, 2013). It is also argued that relative to academic motivation and engagement that are substantively and practically tied to the academic context and its demands, the three non-academic factors may be considered to be less



**Fig. 1.** Motivation and engagement wheel.

(Reproduced with permission from Martin, A. J. (2010). *Building classroom success: Eliminating academic fear and failure*. London: Continuum and from Lifelong Achievement Group, [www.lifelongachievement.com](http://www.lifelongachievement.com)).

directly tied to the academic context and its demands. Because data are collected only on school days and predominantly during class time or study time, it is predicted that these non-academic constructs will reflect less intra-student variation than the academic motivation and engagement factors. Indeed, not only is the inclusion of these non-academic measures substantively interesting, it also provides additional support for the validity of findings.

### 5. Aims of the present study

Taken together, the present study represents a confluence of theory and methods that guides its design and factor selection. Drawing on child development, transactional, ecological and sociocultural theories, there is a rationale for seeking to better understand the intra- and inter-individual variation that exists in the educational context. Harnessing recent theorizing about multidimensional motivation and engagement, a range of adaptive and maladaptive motivation and engagement factors are feasible for exploring this variation. Given these theories are so centered on human and/or educational development, the notion of time is also critical. The design of this study is such that the linear and non-linear passages of time can be investigated at multiple phases (within the day, between days, between weeks). In one way or another, these theories also emphasize the various contextual and background factors important to account for when seeking to understand unique variance attributable to the academic and non-academic factors of interest. Accordingly, a set of appropriate socio-demographic and prior achievement covariates are to be included as predictors.

To build on the typical large-sample cross-sectional motivation and engagement research conducted to date, the present study collects intensive intra-individual real-time longitudinal data using mobile

electronic devices through the day (up to three times), week (on 5 weekdays), and month (across 4 weeks). At each measurement point, students are asked to rate themselves on a variety of academic (motivation and engagement) and non-academic (self-esteem, life satisfaction, sense of purpose) factors. Based on prior theorizing and research relevant to transactional and ecological perspectives, it is hypothesized there will exist significant variance within the day. It is also hypothesized that given the school context in which the study is conducted, academic factors (motivation and engagement) will evince greater intraday variance than non-academic factors (self-esteem, life satisfaction, sense of purpose). However, there has not been a great deal of clarity regarding the nature of motivation and engagement variation through a day, week and month. Thus, the extent of inter-day and inter-week variance is an open empirical question for this study, as is the question as to whether there are linear (rise or fall) or non-linear (rise and fall) effects through a day, week, and month at school.

### 6. Method

#### 6.1. Sample

The dataset comprised a maximum of 60 observations on each of 15 variables for each of 20 high school students in Year 7 ( $N = 8$ ) and Year 11 ( $N = 12$ ) from one non-government single-sex boys' school in a major city on the east coast of Australia. We propose that  $N = 20$  students may be considered analogous to 20 upper level units in a typical multilevel design. Thus, whereas  $N = 20$  is typically not considered large for single-level designs, for multilevel designs such as in the present study, it is deemed an acceptable number of upper level units (e.g., see Maas & Hox, 2005; Raudenbush & Liu, 2000). Eleven students

were boarders and nine were day students. The school comprised students of mixed ability, though it was higher in school-average achievement and socio-economic status than the national average. The mean age of Year 7 students was 12.02 ( $SD = .54$ ) years and for Year 11 students it was 15.91 ( $SD = .63$ ) years. A total of three students spoke a language other than English at home. The study is part of a broader program of research investigating students' academic and non-academic outcomes at times of transition through major educational stages and in various school structures. Accordingly, Years 7 and 11 were selected as they represented the start of junior high and senior high respectively. Students in the school were randomly selected and invited to participate. Ethics approval was provided by the researchers' university and informed parental consent was required and obtained.

## 6.2. Procedure

Using a mobile device (e.g., PDA; iPod; iPhone; iPad) to record responses into SurveyMonkey, each student was asked to rate themselves up to three times each day of the school week for four weeks. The five school days (rather than the whole seven-day week) were chosen because researchers and school personnel were best able to remind the students to complete their ratings on school days; weekend reminders were difficult. Also, as academic motivation and engagement were a focus, it was important for students to be in situations where these items were meaningful — leading to the emphasis on the five school days. The study was conducted in Term 1 of the school year and the rating periods were the school morning (before lunch), the school afternoon (before the last lesson), and in the evening (during homework/study). Thus, a possible total of 60 responses per student were possible. Most students rated themselves two to three times each day, yielding a total of  $N = 759$  responses. This represented a response rate of approximately two-thirds and an average of 38 responses per student for each motivation, engagement, and non-academic variable under focus. Because multilevel modeling does not require balanced data, the number of measurements per student does not need to be equal as multilevel modeling corrects for differences between complete and incomplete cases (Hox, 2010). At the start of each week all students received reminders and further encouragement to participate. Students' response rates were monitored and students were sent individualized reminders if their response rate was declining. The ordering of items was randomized at the start of each week to guard against any systematic non-response effects at particular points of the week.

## 6.3. Materials

### 6.3.1. Academic measures

Academic motivation and engagement were assessed using select items from the short form of the Motivation and Engagement Scale-High School<sup>1</sup> (MES-HS; Martin, 2011). The MES-HS is an 11-factor instrument that assesses motivation in terms of adaptive motivation, adaptive engagement, maladaptive motivation, and maladaptive engagement (for reliability and validity, see Green, Martin, & Marsh, 2007; Liem & Martin, 2012; Plenty & Heubeck, 2011, 2013; Nagabhushan, 2013). The short form represents each factor with one item. The full form represents each factor with four items, but was deemed too long to administer to students three times each day for four weeks via a mobile device. Further, although multi-item measures are often preferable, such measures may compromise assessment of state experiences; longer self-report measures may confound responses

<sup>1</sup> Notably, three items from the MES were excluded from this study: task management ('I use my study time well and try to study under conditions that bring out my best'), planning ('I try to plan things out before I start working on my homework or assignments'), and anxiety ('In tests and assignments I get quite anxious'). This is because these items cannot be rated in-the-moment throughout the day. Instead, they relate to specific times in a day or an academic term and there are numerous points in a day where such items simply cannot be meaningfully rated.

by introducing greater reflection time, increasing recall bias, and assessing students' perceptions about the questionnaire, and not their perceptions about the real-time activity they are engaged in (see Goetz, Frenzel, Stoeber, & Hall, 2010).

Adaptive motivation is comprised of self-efficacy ('I believe I can do a good job in my schoolwork'), valuing school ('I believe that what I learn in school is important and useful'), and mastery orientation ('I am focused on learning and improving more than competing and being the best'). Adaptive engagement is comprised of persistence ('I persist at schoolwork even when it is challenging or difficult'). Maladaptive motivation is comprised of failure avoidance ('I mainly do my schoolwork to avoid failure or disapproval from parents or the teacher/s') and uncertain control ('I don't think I have much control over how well I do in school'). Maladaptive engagement comprises disengagement ('I often feel like giving up in school or schoolwork') and self-handicapping ('I sometimes reduce my chances of doing well in school (e.g., waste time, not study, disrupt others, procrastinate)'). Students rated items on a scale of 1 ('Strongly Disagree') to 7 ('Strongly Agree').

### 6.3.2. Non-academic measures

Non-academic measures comprised sense of purpose, satisfaction with life, and self-esteem. On all measures students were asked to rate each statement on a 1 (Strongly Disagree) to 7 (Strongly Agree) scale. Given the real-time and intensive longitudinal nature of data collection, only single summary items were administered. *Sense of purpose* ('I feel my life is meaningful') assessed participants' sense of meaning and purpose in their life. It was drawn from the World Health Organisation Quality of Life Instrument (WHOQOL, 1998). The broader scale has previously shown sound reliability (WHOQOL, 1998). *Satisfaction with life* ('In most ways my life is close to my ideal') assessed participants' satisfaction with their life in general. The item was derived from the Satisfaction with Life Scale (Diener, Emmons, Larsen, & Griffin, 1985). The scale has previously demonstrated good reliability (Pavot & Diener, 1993). *Self-esteem* ('Most things I do, I do well') examined respondents' general appraisals of themselves. The item is from the SDQ-II and its broader scale has previously demonstrated sound psychometric properties (Marsh, 2007).

### 6.3.3. Socio-demographic and prior achievement covariates

To most appropriately investigate and interpret intra- and inter-individual motivation and engagement, it is important to control for factors known to be significantly associated with motivation and engagement and which therefore may confound findings. Thus, two major covariates were included in analyses: socio-demographic factors and prior achievement. Socio-demographic factors were grade (Year 7 or Year 11), language spoken at home (0 = English speaking; 1 = non-English speaking), parent/caregiver highest level of education (1 = no formal qualifications, 2 = intermediate school certificate, 3 = higher school certificate, 4 = trade/apprenticeships, 5 = certificate/diploma, 6 = university degree), and day/boarding status (0 = day student; 1 = boarding student). Prior achievement was based on students' results in annual nation-wide assessment of literacy and numeracy (National Assessment Program in Literacy and Numeracy, NAPLAN) that is administered by the Australian Curriculum and Assessment and Reporting Authority (ACARA). NAPLAN is a nationally-standardized test for which school students receive a score for literacy and numeracy. Students reported their NAPLAN scores for literacy and numeracy.<sup>2</sup> As the study was domain-general academic (i.e., not subject-specific), a

<sup>2</sup> To determine the extent to which students' self-reports aligned with actual NAPLAN scores, data were drawn from records of one school in the broader research program. There was no significant difference between self-reported and actual scores for literacy,  $t(340) = -.17, p = ns$  and numeracy  $t(340) = -.45, p = ns$ . This is in line with meta-analysis showing that the correlation between self-reported and actual grades is the highest of any factors associated with achievement (Hattie, 2009).

global prior achievement variable was calculated through averaging the numeracy and literacy scores.

6.4. Data analysis

For the present investigation, the data were conceptualized as a four-level model, consisting of within-day ratings at the first level (Level 1, L1), between-day ratings at the second level (Level 2, L2), between-week ratings at the third level (Level 3, L3), and between-student ratings at the fourth level (Level 4, L4). The multilevel analyses (for details see Goldstein, 2003; Raudenbush & Bryk, 2002) were conducted using MLwiN version 2.26 (Rasbash et al., 2012). In the first set of analyses, a baseline variance components model (Rasbash et al., 2012) was used to evaluate how much variation in each of the measures could be attributed to students (L4), weeks (L3), days (L2), and time within days (L1). Following variance components models, the same random elements and set of measures were analyzed but with (a) the fixed linear and non-linear quadratic effects of time within day, time within week, and time within the sampled month included and (b) socio-demographic and prior achievement fixed effects also included. This second analysis was a test of whether there are linear or non-linear patterns in the academic and non-academic measures throughout the day, week or month and the extent of multilevel variance controlling for covariates potentially correlated with the central measures. A third set of analyses tested for variability in linear and non-linear effects as a function of student. These analyses assessed whether linear or non-linear patterns of motivation and engagement within the day and between days and weeks varied from student to student. For each measure, covariate fixed effects were grade, ethnicity (language spoken at home), day/boarding status, parental education, and prior achievement.

7. Results

7.1. Variance components

The first analysis involved an assessment of the relative within-day (L1), between-day (L2), between-week (L3) and between-student (L4) variance in academic and non-academic measures. The variance components (or null effects; intercept only) model tested for such effects. Findings are presented in Table 1. This table displays unstandardized parameter estimates, percentage of explained variance, and statistical significance for each measure at each of the four levels of the model. For academic and non-academic measures, the bulk of variance is accounted for at the between-student (51 to 83%) and within-day levels (11 to 35%), followed by between-week variance (4 to

10%). Between-day variance (1 to 6%) explained relatively little variance. Thus, as hypothesized, the bulk of variability in motivation and engagement is at the intra-individual level.

Also as hypothesized, the pattern of variance differs between academic and non-academic measures. For example, academic measures evinced relatively more variance within the day (average 24%) compared to non-academic measures (average 11%), whereas non-academic measures yielded relatively more variance between students (average 81%) compared with academic measures (average 67%). Both academic and non-academic measures yielded about the same between-day (average 2–3% for both academic and non-academic) and between-week (average 5–7% for both academic and non-academic) variance. Notwithstanding this, between-day variance was statistically significant for all three of the non-academic measures, whereas significant between-day variance for academic outcomes was limited to six of the eleven measures.

7.2. Models testing for timing effects and controlling for covariates

In a second set of analyses, multilevel variance was explored alongside the linear and non-linear effects of timing. These analyses also controlled for variance attributable to grade, ethnicity, day/boarding status, parent education, and prior achievement. Academic and non-academic measures were modeled in the random component of the model and the timing and covariate factors were modeled in the fixed component of the model. Table 2 presents findings. This table displays unstandardized parameter estimates and statistical significance for each measure and for timing effects at each of the four levels of the model.

With the inclusion of fixed time effects and the covariates, variance within the day, between days, and between weeks is little changed. However, variance between students has declined by 18% for academic outcomes and 15% for non-academic outcomes. After controlling for covariates, the fixed linear and non-linear effects of time generally yield no significant effect on academic and non-academic measures. Thus, variability within the day, for example, cannot be attributable to the systematic effect of morning, afternoon, or evening. It therefore appears that it is not so much the time of day that affects academic and non-academic outcomes, but what is happening at any point in the day that affects these variates.

Similarly, there is no systematic rise or fall of academic and non-academic outcomes through the week or through the month. Thus, variability between days and between weeks is not systematically related to the time of the week or month; rather, it seems that it is the nature of (not the timing of) daily events and circumstances that affect academic and non-academic outcomes. Having said this, as with variance components analyses, relatively little variance was explained at Level 2 (between days) and Level 3 (between weeks).

7.3. Models testing for variability in timing effects from student to student

A third and final set of analyses assessed whether linear or non-linear patterns of motivation and engagement within the day and between days and weeks varied from student to student. Here, each linear and non-linear effect for each academic and non-academic variable was freely estimated as a random effect at Level 4 (student). Significant random student effects are indicated by † in Table 2. With the exception of between-week linear effects, there is no significant variability from student to student in the pattern of motivation and engagement (and non-academic measures). In relation to between-week linear effects, there appears to be significant ( $p < .05$ ) variability between students on self-efficacy, valuing school, and failure avoidance. There is similar variability between students for life satisfaction and sense of purpose. Thus, although the overall linear effects are not significant, the linear pattern of motivation and engagement from student to student can change significantly. It therefore appears that across the course of a month there are different motivation and engagement slopes from student to student.

Table 1  
Variance components analysis for academic and non-academic measures.

	Within day (residual)		Between days		Between weeks		Between students	
	Estimate	%	Estimate	%	Estimate	%	Estimate	%
<i>Academic</i>								
Self-efficacy	.19*	19	.06*	6	.10*	10	.67*	66
Valuing school	.19*	19	.04*	4	.06*	6	.73*	72
Mastery oriented	.27*	26	.06*	6	.08*	8	.63*	61
Persistence	.28*	27	.02	2	.06*	6	.67*	65
Failure avoidance	.15*	15	.01	1	.06*	6	.81*	79
Uncertain control	.33*	34	.05*	5	.09*	9	.49*	51
Self-handicapping	.13*	12	.01	1	.04*	4	.87*	83
Disengagement	.34*	35	.01	1	.08*	8	.55*	56
Mean	.24*	23	.03*	3	.07*	7	.68*	67
<i>Non-academic</i>								
Life satisfaction	.10*	11	.02*	2	.04*	5	.72*	82
Self-esteem	.15*	14	.02*	2	.05*	5	.82*	79
Sense of purpose	.09*	10	.03*	3	.04*	5	.71*	82
Mean	.11*	11	.02*	2	.04*	5	.75*	81

\*  $p < .05$ .

**Table 2**  
Random and fixed effects for academic and non-academic measures.

Random part <sup>a</sup>						
	Within day (residual)		Between days	Between weeks	Between students	
	Estimate		Estimate	Estimate	Estimate	
<i>Academic</i>						
Self-efficacy	.19*		.05*	.10*		.46*
Valuing school	.19*		.04*	.06*		.40*
Mastery orientation	.27*		.06*	.08*		.41*
Persistence	.28*		.02	.06*		.52*
Failure avoidance	.15*		.01	.05*		.66*
Uncertain control	.33*		.05*	.08*		.37*
Self-handicapping	.13*		.01	.04*		.78*
Disengagement	.34*		.01	.08*		.35*
Mean	.24*		.03*	.07*		.49*
<i>Non-academic</i>						
Life satisfaction	.10*		.02*	.04*		.67*
Self-esteem	.15*		.02*	.05*		.70*
Sense of purpose	.09*		.03*	.04*		.60*
Mean	.11*		.02*	.04*		.66*
Fixed part <sup>a</sup>						
	Linear within day	Linear within week	Linear between week	Non-linear within day	Non-linear within week	Non-linear between week
	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate
<i>Academic</i>						
Self-efficacy	-.10	.12	.07 <sup>†</sup>	.03	-.02	-.02
Valuing school	-.27*	-.03	-.04 <sup>†</sup>	.07*	.01	.01
Mastery orientation	.01	.06	-.03	-.01	-.01	.02
Persistence	-.03	-.12	-.07	.01	.02	.02
Failure avoidance	.07	-.01	.10 <sup>†</sup>	-.02	.01	-.01
Uncertain control	-.11	.06	.36	.03	-.01	-.06
Self-handicapping	.02	-.07	-.02	-.01	.01	-.01
Disengagement	-.01	-.09	.24	.01	.01	-.05
Mean	.08	.07	.12	.02	.01	.03
<i>Non-academic</i>						
Life satisfaction	.05	.09	.07 <sup>†</sup>	-.02	-.01	-.01
Self-esteem	.01	.04	-.15	-.02	-.01	.03
Sense of purpose	.09	.01	-.03 <sup>†</sup>	-.03	.01	.01
Mean	.05	.05	.08	.02	.01	.02

Note. In a small number of cases, there were relatively large standard errors, leading to statistical non-significance when the absolute size of the parameter might suggest otherwise. Two are salient: linear within-week uncertain control and self-handicapping. Both have relatively large unstandardized parameters (.36 and .24, respectively), but in both cases, the standard errors are also large (.20 and .19, respectively), leading to non-significance. In related vein, in one or two instances, some relatively small parameters are significant due to relatively small standard errors. However, in such cases the parameter attains significance only by a matter of a small margin (e.g., non-linear within-day valuing,  $B = .07$ ,  $SE = .034$ , leading to a marginal  $t$ -value of 2.06,  $p < .05$ ). Notwithstanding these few exceptions, in the context of the very many estimated parameters, we believe the broader pattern of results and conclusions can be sustained.

<sup>a</sup> Controlling for prior achievement, ethnicity, grade, parent education, day/boarding status.

\* Effect significant at  $p < .05$ .

<sup>†</sup> Effect significantly varies from student to student ( $p < .05$ ).

## 8. Discussion

Whereas the bulk of quantitative motivation and engagement research is typically focused on large samples at one point in time, the present study inverts this approach through its focus on intensive intra-day assessment. Using real-time intensive longitudinal data collected via mobile electronic devices, we sought to quantify the extent to which academic and non-academic outcomes vary through the day, through the week, through the month, and between students. After controlling for socio-demographics and prior achievement, findings showed that the bulk of variance resides within the day and between students and that variability within the day is more associated with academic (motivation and engagement) than non-academic outcomes. Interestingly, there was not so much variability between days – and not so much between weeks. Linear (testing a rise or a fall) and non-linear (testing a rise and fall or fall and rise) effects through the day, week and month were predominantly non-significant. It therefore appears that it is not so much the time of day, week or month that affects academic and non-academic outcomes, but what is happening at any point in the day that is influential. Notwithstanding this, there is

variability between students in motivation and engagement slopes across the month. Thus, although the overall linear effects are not significant, the linear pattern of motivation and engagement from student to student can change significantly. In terms of discriminant validity, consistent with the hypotheses, findings showed greater intra-day variance for academic than non-academic measures.

### 8.1. Findings of particular note

Variability within the day suggests that each lesson (or activity) is a new opportunity to motivate and engage (or de-motivate and disengage) a student. Variability in academic outcomes shows that sustained motivation and engagement is not something teachers can take for granted – rather, it appears very dependent on what is happening at a given moment. Because there is up to 35% within-day (or residual) variance in motivation and engagement, we cannot assume a student is singularly motivated and engaged through the day; similarly, we cannot assume a student is singularly unmotivated or disengaged through the day. The general lack of linear and non-linear effects through the day, week, and month further suggests it is not the time of day or week or

month, but what is actually happening at a particular time that affects motivation and engagement. To better understand this, future studies would need to include measures in which school tasks can be rated by content, level of difficulty (from teachers' and/or students' point of view), choicefulness of task, and type of interaction with the teacher or peers.

Drawing on relevant theory assists our understanding of why there exists such intra-individual variance. Child development and transactional perspectives, for example, emphasize the reciprocity between individual and environment that impacts academic and personal well-being outcomes (Shonkoff & Phillips, 2000). Because environment interacts with the individual to shape responses, there is likely to be intra-individual variability that responds to the different stimuli occurring in every school day (Sameroff, 2009). The transactional model explains development in terms of a set of possibilities depending on how individual and environment transact. In practical terms, every student is experiencing different teachers, peers, and subject matter. Indeed, it is rare for all three to be stable across time for any individual. As adapted from the Greek philosopher Heraclitus, 'No person ever steps in the same river twice, for it's not the same river, and it's not the same person'. Our findings reflect this.

The substantial between-student variance in motivation and engagement is consistent with prior research (Martin, Bobis, Anderson, Way, & Vellar, 2011). According to Martin et al. (2011), 'self-system' constructs such as motivation and engagement are hypothesized to be predominantly student-level constructs. That is, in their own right, motivation and engagement are not defined as contextual factors (Martin, 2009). In a large multilevel study, they demonstrated this to be the case and urged researchers to appropriately recognize motivation and engagement as intra-psycho constructs for which there exists substantial inter-individual variance.

Between-student variance was greatest for non-academic measures. Consistent with domain-specificity contentions (e.g., Green et al., 2007), academic measures are likely to be more impacted by the academic setting than non-academic measures, leading to greater intra-day and intra-week variance for academic measures than non-academic measures. To the extent that this is the case, academic factors will reflect more intra- and inter-day variance and non-academic factors will reflect individual differences and thus greater between-student variance.

### 8.2. Implications for intervention

For psycho-educational intervention to be effective, it is vital to weight it appropriately to the level at which the bulk of variance in target phenomena resides. If substantial variance resides within the day, then intervention ought to be directed at lessons and activities within the day. Similarly, if much variance resides at the student level, then organizational (e.g., whole-school) approaches are unlikely to be as effective as differentiated student-focused intervention that adjusts and tailors to the needs of individual students. In fact, the present results suggest intervention should be both person- and activity-centered. Person-centered intervention would target individual students and differentiate where possible. Activity-centered intervention would recognize that every lesson/activity matters. Every lesson/activity is an opportunity to engage (or disengage) and promote (or impede) student outcomes. In both cases, pedagogy would be the focus. Quality pedagogy would differentiate instruction to map onto individual students' needs (student-centered) and also structure and deliver the lesson and its activities (activity-centered) to optimally motivate and engage (Hattie, 2009, 2012).

### 8.3. Implications for theory

Findings reinforce major perspectives on child development that articulate the complex and dynamic interplay of the individual and

his/her context – and the intra-individual implications this holds (Shonkoff & Phillips, 2000). Although sharing the same academic environment, each student experiences a distinct reality that gives rise to significant intra- and inter-individual variance in motivation and engagement. Following from these theories, it might be contended that through the environment's interaction with each student (and his/her personal characteristics, including biological attributes), there is intra-individual variability in motivation and engagement that responds to dynamic stimuli through the school day. In a similar vein, findings support the transactional model that emphasizes the dynamic interplay between individual and environment shaping development over time to yield distinct profiles across points in time (Sameroff, 2009). As discussed earlier, the transactional model also emphasizes intra- and inter-individual heterogeneity that is a function of the dynamic interplay of person and environment (Gonzalez, 2009; Sameroff, 2009). In the present study, heterogeneity spanned intra-day variance at Level 1 of the data structure through to between-student variance at Level 4 of the structure. In relation to ecological perspectives, findings support Bronfenbrenner and Morris's (2006) observation that the inner layers of the child's ecology reflecting the moment-to-moment transactions are influential in the child's outcomes. Consistent with sociocultural perspectives, students appear to idiosyncratically internalize their academic context to evoke different motivational expression through the day (Nolen & Ward, 2008; Turner, 2001; Turner & Patrick, 2004; Walker et al., 2004; McCaslin, 2004; Walker, 2010).

### 8.4. Implications for methodology

The study demonstrated that mobile technology can be usefully employed to collect intensive intra-individual longitudinal motivation and engagement data through the day, week and month. This use of technology allowed us to conduct more participant-friendly data collection. In addition, linking to an online survey tool greatly expedited the data entry and management process (Beal & Weiss, 2003). This mobile technology significantly reduced delays between actual events and reports of motivation and engagement at or immediately following these events, ideally reducing bias in retrospection and the like (Bolger et al., 2003; Walls & Schafer, 2006). The real-time data resulting from this use of technology enabled multiple records for each participant, leading to an intensive longitudinal dataset (Walls & Schafer, 2006). Intensive longitudinal data structured in an appropriate way was essential to addressing the substantive issues at hand.

We also make the point that the conceptual frameworks on which we draw are a basis for considering other methodological approaches to investigating the issues at hand in our study. For example, sociocultural and ecological approaches might argue for intensive qualitative work that seeks to illuminate the lived experiences that quite dynamically reflect the momentary processes of individual students in the educational context (e.g., see Walker et al., 2004; McCaslin, 2004; Walker, 2010). In terms of quantitative work, transactional and child development perspectives might lend themselves to restructuring the data so that time series or cross-lagged models can be conducted to understand how momentary experiences might predict subsequent experiences across the day, week, and month at school (e.g., Sameroff, 2009). Hence, although we have pursued a multilevel approach to investigate the issues at hand, there are other approaches that offer distinct perspectives and insights into the phenomena of interest.

### 8.5. Limitations and directions for future research

The present study has addressed a number of issues relevant to real-time motivation and engagement over the course of a month at school. There are, however, a number of limitations important to note and which have implications for future research. First, it will be recalled that question ordering was randomized at the start of each week. To the extent that response bias within the day and within the week can

arise, future research might randomize items at each administration during the day. Second, the study was conducted in a boys' school. It is unclear whether different results would emerge with the inclusion of girls. However, given prior research has identified gender effects in motivation and engagement (e.g., Martin, 2007, 2009; Weaver-Hightower, 2003), future research should employ a more balanced design with respect to gender. Third, the data were collected within one month, and each month in the school year inevitably carries a different meaning to students, limiting what we can infer across the academic year as a whole. Also, as there were only four weeks, interpretations of between-week patterns are to be made with due caution.

Caution with regard to measures is also urged. On this, a fourth limitation is that our measures comprised single-item indicators for which internal consistency could not be established, nor structural validity tested. Future research might consider multiple indicator constructs, although intensive longitudinal researchers will need to carefully balance the choice and number of items against the time it will take for participants to complete them at each occasion. Fifth, we recognize that diverse motivation and engagement frameworks exist and that future work might seek to investigate, for example, more nuanced and differentiated approaches to engagement such as that under the tripartite cognitive, emotional, and behavioral engagement model articulated by Fredricks et al. (2004). Sixth, we demarcated focal constructs into academic and non-academic factors. Because our study was closely embedded in the academic context, we predicted that the academic (motivation and engagement) factors would evince more intra-individual (e.g., intra-day) variation than non-academic measures that are not so likely to be affected by the idiosyncrasies of the academic context and its demands. However, another interpretation is that the motivation and engagement factors are more state-like (Green, Martin, & Marsh, 2007), whereas the three non-academic factors are more trait-like. To the extent that this is the case, we do not know if more state-like non-academic factors (e.g., mood) would also demonstrate intra-individual variation along the lines of that demonstrated by the academic factors in this study. Further work is thus needed to disentangle academic from non-academic and state- from trait-like factors.

Finally, our study was based on a sample size that may be deemed small by 'traditional' educational psychology standards. However, we make the point that this is not unreasonable given the intra-individual focus and the vast number of time points assessed. In the Method section, we noted that  $N = 20$  students may be considered analogous to 20 upper level units in a typical multilevel design. Thus, whereas  $N = 20$  is typically not considered large for single-level designs, for multilevel designs, it is deemed an acceptable number of upper level units (e.g., see Maas & Hox, 2005; Raudenbush & Liu, 2000). Having said this, it is also the case that with fewer units, standard errors are larger (Snijders, 2005), potentially disproportionately leading to a conclusion of non-significance. In the present study, however, there was no risk of such erroneous conclusions because the absolute parameter estimates were so large for the upper ( $N = 20$ ) level that all such parameters were statistically significant. Notwithstanding this, future research might look to increase the number of students at the upper level of the design.

## 9. Conclusion

With developments in mobile technology as well as widespread and cost-effective accessibility, there are opportunities for educational researchers to employ complex research designs and collect real-time intra-individual data with relative ease. The present study collected intensive real-time longitudinal motivation and engagement data at multiple points in the day, each day, for four school weeks. Consistent with major developmental and psycho-educational theorizing, findings demonstrate intra-day and inter-student variability in motivation and engagement, suggesting activity- and person-centered approaches to enhance students' motivation and engagement. We conclude that for

optimal motivation and engagement to occur and be sustained, every moment of every day for every student matters.

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