

1 Applying the Integrated Trans-Contextual Model to Mathematics Activities in the Classroom
2 and Homework Behavior and Attainment

3
4 Martin S. Hagger^a, Sarwat Sultan^b, Sarah J. Hardcastle^a, Johnmarshall Reeve^c, Erika Patall^d,
5 Barry Fraser^e, Kyra Hamilton^f, Nikos L. D. Chatzisarantis^a

6
7 ^aLaboratory of Self-Regulation and Health Psychology and Behavioural Medicine Research
8 Group, School of Psychology and Speech Pathology, Faculty of Health Sciences, Curtin
9 University, Perth, Australia emails: martin.hagger@curtin.edu.au,
10 sarah.hardcastle@curtin.edu.au, nikos.chatzisarantis@curtin.edu.au

11 ^bDepartment of Applied Psychology, Bahauddin Zakariya University, Multan, Pakistan, email:
12 sarwatsultan@hotmail.com

13 ^cDepartment of Education, Korea University, Seoul, South Korea, email: reeve@korea.ac.kr

14 ^dCollege of Education, Department of Educational Psychology, University of Texas at Austin,
15 United States of America, email: patall@austin.utexas.edu

16 ^eScience and Mathematics Education Centre, Curtin University, Perth, Australia, email:
17 b.fraser@curtin.edu.au

18 ^fSchool of Applied Psychology, Griffith University, Brisbane, Australia,
19 kyra.hamilton@griffith.edu.au

20
21 FULL CITATION: Hagger, M. S., Sultan, S., Hardcastle, S. J., Reeve, J., Patall, E. A., Fraser,
22 B. J., Hamilton, K., & Chatzisarantis, N. L. D. (2016). Applying the trans-contextual model to
23 mathematics activities in the classroom and homework behaviour and attainment. *Learning*
24 *and Individual Differences*. Advance online publication. doi: 10.1016/j.lindif.2015.11.017

25
26 Correspondence concerning this article should be addressed to Martin S. Hagger, Laboratory of
27 Self-Regulation and Health Psychology and Behavioural Medicine Research Group, School of
28 Psychology and Speech Pathology, Faculty of Health Sciences, Curtin University, GPO Box
29 U1987, Perth, WA6845, Australia, tel: +61 8 92662215, fax: +61 8 92662464, email:
30 martin.hagger@curtin.edu.au

31

32

Abstract

The aim of the present study was test hypotheses of the trans-contextual model. We predicted relations between perceived autonomy support, autonomous motivation toward mathematics learning activities in an educational context, autonomous motivation toward mathematics homework in an out-of-school context, social-cognitive variables and intentions for future engagement in mathematics homework, and mathematics homework outcomes. Secondary school students completed measures of perceived autonomy support from teachers and autonomous motivation for in-class mathematics activities; measures of autonomous motivation, social-cognitive variables, and intentions for out-of-school mathematics homework; and follow-up measures of students' mathematics homework outcomes: self-reported homework engagement and actual homework grades. Perceived autonomy support was related to autonomous motivation toward in-class mathematics activities. There were trans-contextual effects of autonomous motivation across educational and out-of-school contexts, and relations between out-of-school autonomous motivation, intentions, and mathematics homework outcomes. Findings support trans-contextual effects of autonomous motivation toward mathematics activities across educational and out-of-school contexts and homework outcomes.

Key words: trans-contextual model; autonomous motivation; theoretical integration; self-determination theory; theory of planned behavior

20

1 **1. Introduction**

2 Motivation is central to successful learning and education-related outcomes in the
3 classroom (Steinmayr & Spinath, 2009). Autonomous motivation, in particular, has been
4 consistently shown to be related not only to engagement in class activities and adaptive
5 educational outcomes, such as better overall grades, among school children (Deci, Vallerand,
6 Pelletier, & Ryan, 1991; Pintrich & Degroot, 1990), but also self-directed learning activities
7 outside of the class, such as homework effort and attainment (Reeve, 2002). According to self-
8 determination theory (Deci & Ryan, 2000), autonomous motivation affects educational
9 persistence, effort, and performance because activities pursued for autonomous reasons are
10 likely to satisfy children's psychological needs for autonomy, competence, and relatedness.
11 The satisfaction of these needs is required for optimal functioning and tends to be accompanied
12 by perceptions of personal agency, interest, satisfaction, and positive affect. The pursuit of
13 autonomously-motivated activities is self-reinforcing precluding the need for extrinsic
14 reinforcement. Educators have, therefore, advocated fostering autonomous motivation in
15 classroom contexts (Reeve, Bolt, & Cai, 1999; Reeve & Jang, 2006). Furthermore, children
16 that perceive their teachers as autonomy supportive is related to children's autonomous
17 motivation and adaptive educational outcomes in the classroom (Ferguson, Kasser, & Jahng,
18 2011; Guay, Boggiano, & Vallerand, 2001). Fostering autonomous motivation in the classroom
19 likely produces better academic outcomes by instilling autonomous motivation in class but also
20 autonomous motivation toward self-directed learning outside school, such as homework
21 engagement. There is, however, a relative dearth of research providing direct tests of these
22 effects (Hagger & Chatzisarantis, 2012; Vallerand, 1991). The present study adopted the
23 integrated trans-contextual model of motivation to examine relations between secondary school
24 students' perceived autonomy support toward mathematics activities in a school context,
25 autonomous motivation toward mathematics activities in school, autonomous motivation

1 toward mathematics homework outside of school, and social cognitive beliefs about doing
2 mathematics homework in future.

3 *1.1. The trans-contextual model*

4 The trans-contextual model outlines the process by which school students' autonomous
5 motivation toward activities in an educational context is transferred to autonomous motivation,
6 and intentions and future engagement in educational activities outside of school (Hagger,
7 Chatzisarantis, Culverhouse, & Biddle, 2003). Model hypotheses are summarized in Figure 1
8 and Table 1¹. A central premise of the trans-contextual model is that autonomous forms of
9 motivation are adaptive and lead to increased persistence on tasks without the need for any
10 externally-referenced contingency. Autonomous motivation is defined as acting for reasons of
11 interest and enjoyment in the belief that the self is the origin of the behavior. Autonomous
12 motivation is contrasted with controlled motivation, defined as acting out of externally-
13 referenced obligation or reinforcement and leads to behavioral persistence only as long as the
14 external contingency is present. Promoting autonomous forms of motivation in educational
15 contexts is considered adaptive as it has been linked with higher levels of persistence on
16 educational tasks (Reeve et al., 1999). Teachers can foster greater autonomous motivation by
17 adopting autonomy-supportive styles that promote students' interest and self-directed learning.
18 Students' perceived autonomy support serves as a proxy measure teachers' autonomy support.
19 The link between perceived autonomy support and autonomous motivation toward activities in
20 educational contexts forms the first hypothesis of the trans-contextual model. School students'
21 perceived autonomy support from teachers with respect to classroom educational activities is
22 expected to be associated with their autonomous motivation (H₁) in the classroom.

23 The transfer of motivation across educational and out-of-school contexts is central to the
24 trans-contextual model and consistent with Vallerand's (1997) proposal of significant relations
25 between contextual-level motivational orientations. Hagger et al. (2005) proposed that cues in a

¹Readers are encouraged to refer to Table 1 and Figure 1 to augment understanding of the model hypotheses.

1 different context to the educational context, such as performing educational activities (e.g.,
2 mathematics homework) in an out-of-school context (e.g., home), will likely activate the
3 ‘script’ or schema for mathematics activity engagement so that it serves as a guide or template
4 for motivational responses and linked patterns of action in that context (Vallerand, 2000).
5 Based on this mechanism, autonomous motivation toward mathematics activities in the
6 educational context is proposed in the model to be related to autonomous motivation toward
7 mathematics homework in the out-of-school context (H₂).

8 The trans-contextual model also proposes that autonomous forms of motivation toward
9 mathematics activities out-of-school contexts will be related to beliefs and intentions regarding
10 engagement in those activities in the future. The trans-contextual model integrates the theory of
11 planned behavior (Ajzen, 1991, 2015) to delineate relations between autonomous motivation,
12 beliefs about engaging in behavior, and intentions and future behavioral enactment. According
13 to the theory, *behavioral intention*, a motivational variable that reflects the degree of planning
14 and effort an individual is likely to invest in pursuing a given behavior, is the proximal
15 determinant of behavior. Behavioral intention is a function of *attitudes*, an individual’s positive
16 or negative evaluation of engaging in a future target behavior, *subjective norms*, beliefs that
17 social agents pressurize one into engaging in the behavior, and *perceived behavioral control*,
18 beliefs regarding personal capacity to engage in the behavior. Intentions are hypothesized to
19 mediate effects of attitudes, subjective norms and perceived behavioral control on actual
20 behavior (Ajzen, 1991, 2015). Consistent with self-determination theory, individuals are
21 compelled to satisfy their psychological needs and need satisfaction will engender autonomous
22 motivation to engage in specific behaviors likely to be need satisfying (Hagger, Chatzisarantis,
23 & Harris, 2006). As a consequence, individuals will tend to align their attitudes, perceived
24 control, and intentions with their autonomous motives, a strategic response as it will prepare
25 the individual to engage in autonomously-motivated behaviors in future (Deci & Ryan, 2000;
26 Koestner, Bernieri, & Zuckerman, 1992). The inclusion of beliefs and intentions from the

1 theory of planned behavior therefore provides a means of testing the process by which
2 contextual-level motives lead to future behavior. The distinction between autonomous
3 motivation as generalized motives toward a behavior and intentions and other constructs from
4 the theory of planned behavior as specific beliefs regarding future action is reflected in the
5 measures used to tap these constructs.

6 In the current research, autonomous motivation toward mathematics homework in an out-
7 of-school context is proposed to be related to children's attitudes (H_3) and perceived behavioral
8 control (H_4) toward mathematics education. The mechanism behind these effects is that school
9 students' personal- and control-oriented beliefs are likely to be aligned with autonomous
10 motivational orientations (McLachlan & Hagger, 2010a, 2011a, 2011b). The effect of
11 autonomous motivation on subjective norms is expected to be negative (H_5) because subjective
12 norms reflect students' beliefs that social agents' want them to engage in homework behavior
13 and is generally interpreted as pressuring and controlling. The effects of autonomous
14 motivation toward mathematics activities in the education context on attitudes (H_6), perceived
15 behavioral control (H_7), and subjective norms (H_8) are also predicted to be zero as the effects
16 are expected to be indirect through autonomous motivation in the out-of-school context.

17 Focusing on the proximal belief-based antecedents of the theory of planned behavior,
18 intentions are hypothesized to be a function of attitudes (H_9), perceived behavioral control
19 (H_{10}), and subjective norms (H_{11}). Intentions are hypothesized to be a direct predictor of
20 mathematics homework outcomes (H_{12}) and the direct effects of the attitude (H_{13}) and
21 subjective norms (H_{14}) variables on mathematics homework outcomes should be null,
22 consistent with the hypothesis that all the effects of social-cognitive constructs on behavior are
23 mediated by intention. The only exception is perceived behavioral control which is
24 hypothesized to predict mathematics homework outcomes directly (H_{15}) when perceived
25 behavioral control serves as a proxy for actual control over behavior (Ajzen, 1991). Finally, we
26 also hypothesized that there would be no direct effects of perceived autonomy support on

1 intentions (H_{16}) and mathematics homework outcomes (H_{17}) on mathematics homework
2 behavioral engagement because we expect the influence of this variable on these outcomes to
3 be mediated by motivational and social-cognitive constructs in the model (see Figure 1 and
4 Table 1).

5 There are also several important indirect effects in the trans-contextual model that
6 provide detail on the processes by which the motivational factors in the educational context
7 affect motivation, intention, and action in the out-of-school context (see Table 1). This network
8 of relationships is referred to as a ‘motivational sequence’ (c.f., Vallerand, 1997). Consistent
9 with previous research (McLachlan & Hagger, 2010b), perceived support for autonomy is not
10 only likely to foster autonomous motivation in that context, but also autonomous motivation
11 toward similar activities outside of school, such as mathematics homework, mediated by
12 autonomous motives in the school context (H_{18}). Consistent with previous integrations of self-
13 determination theory and the theory of planned behavior (Hagger & Chatzisarantis, 2009b;
14 Hagger et al., 2006), autonomous motivation in the educational context is also expected to be
15 related to intentions to engage in mathematics homework in the future mediated by
16 autonomous motivation at home and the proximal predictors of intention from the theory of
17 planned behavior, namely, attitudes (H_{19}) and perceived behavioral control (H_{20}). Autonomous
18 motivation in the educational context is also proposed to affect mathematics homework
19 outcomes mediated by autonomous motivation at home, intention, and attitudes (H_{21}) and
20 perceived behavioral control (H_{22}). Similarly, autonomous motivation toward homework is
21 expected to predict intentions mediated by the attitude (H_{23}) and perceived behavioral control
22 (H_{24}) variables. Autonomous motivation at home is also expected to indirectly predict
23 mathematics homework outcomes mediated by attitudes (H_{25}) and perceived behavioral control
24 (H_{26}) and intentions. Finally, consistent with predictions from previous tests of the trans-
25 contextual model (Hagger et al., 2005; Hagger et al., 2003), perceived autonomy support is
26 expected to have a significant indirect effect on mathematics homework behavioral

1 engagement via the entire motivational sequence (H_{27}). This effect indicates the behavioral
2 relevance of autonomy support in an educational context to actual engagement in homework
3 behavioral outcomes outside of school².

4 *1.2. The present study*

5 An increasing body of research from multiple research groups has supported the core
6 proposals of the trans-contextual model including the transfer of autonomous forms of
7 motivation across education and out-of-school contexts and the effect of autonomous forms of
8 motivation in both contexts on intentions to engage in related activities in an out-of-school
9 context (e.g., González-Cutre, Sicilia, Beas-Jiménez, & Hagger, 2014; Hagger &
10 Chatzisarantis, 2012; Hagger et al., 2005; Hagger et al., 2003; Jackson, Whipp, Chua,
11 Dimmock, & Hagger, 2013; Shen, McCaughtry, & Martin, 2008; Standage, Gillison,
12 Ntoumanis, & Treasure, 2012). However, a limitation of previous research adopting the model
13 is the exclusive focus on physical education and leisure-time physical activity (Hagger &
14 Chatzisarantis, 2012, 2015). The present study reports the application of the trans-contextual
15 model to school students' mathematics activities in the classroom and homework activities
16 outside of school. The current test will add to the literature by contributing evidence of the
17 generalizability of the model to multiple educational domains. The model was developed to be
18 generalizable across contexts and populations, and the theories on which the model is based
19 adopt a similar perspective. We therefore expect the proposed pattern of predictions to hold
20 regardless of the target behavior, subject, and population. Hagger and Chatzisarantis' (2015)
21 contend that the model "may have a broader scope as a generalizable framework that explains
22 the processes by which motivation is transferred across educational and out-of-school
23 contexts" (p. 2-3). The research may serve as a gateway for the future application of the model
24 in other core academic domains such as science and language. Focusing on mathematics

²We did not hypothesize indirect effects further down the causal chain if the hypothesis if one of the effects in the causal chain was hypothesized to be non-significant.

1 homework is important given good evidence that homework engagement has significant effects
2 on mathematics classwork and overall school grades (Trautwein, 2007). The focus on
3 promoting better mathematics behavioral outcomes is pertinent and timely given evidence that
4 standards in mathematics are declining with students increasingly opting to study subjects
5 outside math- and science-based disciplines (Hodgen, Kuchemann, Brown, & Coe, 2009;
6 NCES, 2012).

7 **2. Materials and methods**

8 *2.1. Participants*

9 School students (N = 265) were recruited from four co-educational state primary schools
10 in metropolitan Perth, Western Australia to participate in the study. Participants were in school
11 years 6 and 7 and aged between 10 and 12 years. Ethical clearance for the study protocol was
12 secured from the [University omitted for masked review] Health Research Ethics Committee
13 and the Government of Western Australia Department of Education prior to data collection.
14 Participants' demographic information was gained from students' records held by the School
15 registry including whether their domicile was urban or rural and their ethnic background.
16 Socioeconomic status was estimated from statistics for the catchment area from which the
17 schools sourced their students.

18 *2.2. Research design*

19 We employed a three-wave prospective correlational design consistent with previous
20 studies adopting the trans-contextual model. Measures were adapted versions of those used in
21 previous tests of the trans-contextual model. In the first-wave of data collection, self-report
22 measures of students' perceived autonomy support for mathematics by teachers and
23 autonomous and controlled forms of motivation for mathematics activities in a classroom
24 context were administered. One week later, a second-wave questionnaire was administered
25 including measures of theory of planned behavior components (Ajzen, 2003) and autonomous
26 and controlled forms of motivation for mathematics homework (Ryan & Connell, 1989). After

1 five weeks, self-reported homework engagement was measured. In addition, averaged grades
2 for the formally-assessed homework assignments ($N = 8$ to 10) completed by the students over
3 the five-week follow-up period were sourced from participants' mathematics teachers.

4 *2.3. Measures*

5 Participants completed questionnaires containing self-report measures of the
6 psychological constructs of the trans-contextual model that had been previously-validated in
7 tests of the model in other contexts. Measures were modified to make reference to the
8 behaviors of interest: engaging in mathematics activities in the classroom or mathematics
9 homework engagement. Measures included in the questionnaires were: perceived autonomy
10 support for mathematics by teachers using an adapted version of the Perceived Autonomy
11 Support Scale for Exercise Settings (PASSES; Hagger et al., 2007); autonomous (intrinsic and
12 identified regulations) and controlled (external and introjected regulations) forms of motivation
13 from self-determination theory based on Ryan and Connell's (1989) perceived locus of
14 causality inventory in the school (mathematics lessons) and out-of-school (homework)
15 contexts; and homework intentions, attitudes, subjective norms, and perceived behavioral
16 control from the theory of planned behavior developed according to published guidelines
17 (Ajzen, 2003). Mathematics homework outcomes, the target dependent variable, was assessed
18 by self-reported homework engagement and students' aggregate grades attained for their
19 homework assignments over the five-week period between the second and third waves of data
20 collection. Self-reported homework engagement was based on measures of behavior used
21 within the trans-contextual model in other contexts (Hagger et al., 2005; Hagger et al., 2003)
22 and students' grades was an average grade across the eight and ten pieces of assessed
23 homework that students had completed in the five-week period. Full details of measures used
24 in the current study are provided in the measures table available as online supplemental
25 material (Appendix A). We also included a self-report measure of past effort on mathematics
26 homework at the second wave of data collection which was used as a control variable in the

1 model to account for previous mathematics homework engagement consistent with previous
2 research (Bagozzi & Warshaw, 1990).

3 *2.4. Data analysis*

4 Data were analyzed using variance-based structural equation modeling (VB-SEM), also
5 known as Partial Least Squares analysis, using the Warp PLS v.4.0 statistical software (Kock,
6 2012). All latent variables in the structural equation model were indicated by multiple items. A
7 single latent dependent variable of mathematics homework outcomes was used indicated by the
8 two items from the self-reported mathematics homework engagement scale and the averaged
9 student homework grade score. Furthermore, in order to keep the number of psychological
10 measures manageable, we computed a single index of autonomous motivation in each context
11 based on a weighted average of the motivational regulation constructs from the perceived locus
12 of causality. Specifically, we computed a *relative autonomy index* by assigning weights to each
13 of the intrinsic motivation (+2), identified regulation (+1), introjected regulation (-1), and
14 extrinsic regulation (-2) items from the perceived locus of causality measures. Each weighted
15 item was then summed to form three items to indicate a latent autonomous motivation factor
16 for each context (Vallerand, 2007). The hypothesized relations among the variables in the
17 trans-contextual model summarized in Figure 1 were set as free parameters in the model. Past
18 mathematics homework effort was included as a control variable which predicted all other
19 variables in the model.

20 Construct validity of the latent factors was established using the average variance
21 extracted (AVE) and composite reliability coefficients (ρ) (Diamantopoulos & Sigauw, 2000).
22 Discriminant validity is supported when the square-root of the AVE for each latent variable
23 exceeds its correlation coefficient with other latent variables. Adequacy of the proposed model
24 was established using multiple criteria for goodness of including the goodness-of-fit (GoF)
25 index (Tenenhaus, Vinzi, Chatelin, & Lauro, 2005), average path coefficient (APC), average
26 R^2 (ARS), and average variance inflation factor for model parameters (AVIF) statistics (Kock,

1 2013). Hypothesized mediation effects were tested by calculating indirect effects using a
2 bootstrap resampling method with 100 replications (Kock, 2013).

3 3. Results

4 3.1. Participants

5 Thirty-two participants dropped out of the study due to absences across the waves of data
6 collection resulting in a final sample size of 233 participants (boys = 112, girls = 121; M age =
7 11.49, $SD = 0.61$). Attrition analyses indicated that there were no significant differences in the
8 age ($t(263) = 1.001, p = .318, d = .189$), gender distribution ($\chi^2(1) = 0.016, p = .899, d = .008$)³,
9 and psychological variables (perceived autonomy support and autonomous and controlled
10 forms of motivation in the school context) measured in the first wave (Wilks' Lambda = .983,
11 $F(5,259) = .913, p = .473, d = .122$) between participants that dropped out of the study and
12 those that were retained across the three waves of data collection. The vast majority of
13 participants were classified as Australians of European descent ($n = 218; 93.60\%$) with some
14 minority groups represented including Australians of Indigenous Australian and Torres Strait
15 Islander ethnicity ($n = 8; 3.4\%$), Australians of Asian ethnicity ($n = 4; 1.70\%$), and participants
16 of African, Arabic, and South American ethnicity ($n = 3; 1.20\%$). All participants were urban
17 dwelling, defined as living within the bounds of the metropolitan Perth. School catchment
18 areas were classified as middle-ranking socioeconomic status based on statistics from the
19 Western Australian Department of Education.

20 3.2. Preliminary analyses

21 Measurement-level statistics from the VB-SEM confirmed the latent variables met
22 criteria for construct and discriminant validity. Composite reliability coefficients, AVE, and
23 intercorrelations for model variables are presented in Table 3. Reliability coefficients exceeded
24 the .700 criterion for all factors and AVE values approached or exceeded the recommended

³We also computed the zero-order correlations between the psychological constructs in the current study and gender and age. We found no statistically significant correlations and we did not, therefore, include these constructs as control variables in subsequent structural equation models.

1 0.500 criterion (Diamantopoulos & Sigauw, 2000). Factor correlations among the latent
2 variables also indicated no problems with discriminant validity. In all cases, the square root of
3 the AVE for each latent variable approached or exceeded the correlation between the variable
4 and all other variables. The high factor loadings (median = 0.973), composite reliability ($\rho =$
5 .961), and AVE (.892) statistics for the mathematics homework outcomes variable justified our
6 decision to include the self-reported mathematics engagement and grades as indicators of a
7 single dependent variable. Goodness of fit indices revealed acceptable overall fit of the model
8 with the data according to the adopted goodness-of-fit indices (Table 2).

9 *3.3. Model effects*

10 Standardized parameter estimates for the structural relations among the trans-contextual
11 model factors in the proposed model are given in Figure 2. Perceived autonomy support had a
12 statistically significant effect on autonomous motivation toward mathematics in school (H_1).
13 There was a significant trans-contextual effect of autonomous motivation between the school
14 and home contexts (H_2). Autonomous motivation in the home context predicted attitudes (H_3),
15 but also positively predicted subjective norms, which was contrary to our predictions, so we
16 rejected our hypothesis (H_5). There was no effect of autonomous motivation at home on
17 perceived behavioral control leading to the rejection of the hypothesis (H_4). Contrary to
18 predictions, there was a significant direct effect of autonomous motivation in the school
19 context on attitudes toward mathematics homework, which led us to reject the hypothesis (H_6).
20 There were no direct effects of autonomous motivation in school on perceived behavioral
21 control (H_7) and subjective norms (H_8) as hypothesized. Attitudes (H_9) and subjective norms
22 (H_{10}) exhibited significant effects on intention toward mathematics homework as predicted, but
23 there was no effect for perceived behavioral control, which led us to reject the hypothesis
24 (H_{11}). There was no direct effect of attitudes on mathematics homework outcomes (H_{13}). In
25 contrast, we hypothesized a null direct effect of subjective norms but found a statistically
26 significant effect leading to a rejection of this hypothesis (H_{14}). Perceived behavioral control

1 had no direct effect on mathematics homework outcomes, so we rejected our hypothesis (H₁₅).
2 The hypothesized effect of intention on mathematics homework outcomes was statistically
3 significant (H₁₂). The direct effects of perceived autonomy support on intention (H₁₆) and
4 mathematics homework outcomes (H₁₇) were not statistically significant consistent with our
5 predictions.

6 We also predicted that the distal constructs in the model would have indirect effects on
7 proximal psychological and mathematics homework outcome variables mediated by the
8 proposed motivational sequence. As predicted, there were significant indirect effects of
9 perceived autonomy support for mathematics in school on autonomous motivation in the home
10 context mediated by autonomous motivation in the school context (H₁₈, $\beta = .151$, CI₉₅ [.077,
11 .225], $p < .001$). Autonomous motivation in the school context was also hypothesized to
12 predict mathematics homework intentions and mathematics homework outcomes mediated by
13 autonomous motivation at home and the attitude and perceived behavioral control constructs.
14 Given that the effect of autonomous motivation at home on perceived behavioral control was
15 not significant, there were no indirect effects on intentions (H₂₀) and mathematics homework
16 outcomes (H₂₂) through this variable, leading to a rejection of our hypotheses. There were,
17 however, significant indirect effects of autonomous motivation in school on intentions (H₁₉, β
18 = .138, CI₉₅ [.030, .246], $p < .001$) and mathematics homework outcomes (H₂₁, $\beta = .038$, CI₉₅
19 [.024, .062], $p = .002$) through autonomous motivation at home and attitudes as predicted. The
20 indirect effect of autonomous motivation at home on intention mediated by attitude was also
21 significant (H₂₃, $\beta = .232$, CI₉₅ [.130, .334], $p < .001$), although the indirect effect through PBC
22 was not, so we rejected our hypothesis (H₂₄). Similarly, there were significant indirect effects
23 of autonomous motivation at home on mathematics homework outcomes mediated by attitudes
24 and intention (H₂₅, $\beta = .087$, CI₉₅ [.040, .134], $p < .001$). There was no indirect effect of out-of-
25 school autonomous motivation on mathematics homework outcomes mediated by perceived
26 behavioral control and intention, contrary to hypotheses (H₂₆). There was also no effect of out-

1 of-school autonomous motivation on mathematics homework outcomes mediated by subjective
2 norms and intention, the significant effects of autonomous motivation on subjective norms and
3 subjective norms on intention notwithstanding. Finally, consistent with hypotheses, we found a
4 significant overall indirect effect of perceived autonomy support on mathematics homework
5 outcomes mediated by the motivational sequence involving autonomous motivation in both
6 contexts, the proximal antecedents of intention, and intention (H_{27} , $\beta = .042$, $CI_{95} [.009, .075]$,
7 $p = .021$).

8 **4. Discussion**

9 The aim of the current study was to test the effects of school students' perceived
10 autonomy support and autonomous motivation toward mathematics activities in the classroom
11 on autonomous motivation, belief based-constructs from the theory of planned behavior
12 (attitudes, subjective norms, and perceived behavioral control), intention, and mathematics
13 homework outcomes with respect to mathematics homework in an out-of-school context. The
14 research adopted the trans-contextual model (Hagger & Chatzisarantis, 2012, 2015; Hagger et
15 al., 2003), an integrated approach drawing from multiple theories. Findings supported the
16 majority of the proposed trans-contextual model effects and consistent with the proposed
17 effects in previous studies adopting the model, particularly the trans-contextual effect of
18 autonomous motivation (Hagger & Chatzisarantis, 2015). Current findings make an important
19 contribution to knowledge by demonstrating that the propositions of the trans-contextual model
20 generalize to an academic discipline given that previous tests have been confined to the
21 physical education context and out-of-school leisure-time physical activity participation. This
22 is consistent with the generalizability hypothesis proposed by Hagger and Chatzisarantis
23 (Hagger & Chatzisarantis, 2012, 2015) and the constituent theories of the trans-contextual
24 model (Ajzen, 1991; Deci & Ryan, 2000; Vallerand, 1997).

25 While we found support for many of the key proposed effects on the model, particularly
26 the trans-contextual effects, some effects did not support predictions. Prominent among these

1 were the null effects of autonomous motivation on perceived behavioral control, and of
2 perceived behavioral control on intentions. Perceived behavioral control is considered a
3 prominent mediator of the effect of autonomous motivation on intentions and an important
4 construct in the trans-contextual model as it is purported to be akin to competence and self-
5 efficacy. The variance in autonomous motivation shared with perceived behavioral control
6 found in other studies is likely due to the fact that both reflect competence perceptions
7 (Barkoukis, Hagger, Lambropoulos, & Torbatzoudis, 2010; Hagger et al., 2009). The failure to
8 find significant effects of autonomous motivation on the perceived behavioral control construct
9 in the current analysis may be because our measure of perceived behavioral control did not
10 adequately capture competence beliefs but instead focused on perceived control over external
11 constraints on behavior. Previous research has indicated that it is the aspects of perceived
12 behavioral control that focus on self-efficacy that tend to be more strongly linked to intentions
13 rather than beliefs about controllability, which may account for the zero effect for perceived
14 behavioral control on intentions in the current study (Ajzen, 2002; Armitage & Conner, 1999;
15 Hagger, Chatzisarantis, & Biddle, 2001; Terry & O'Leary, 1995). Future research may do well
16 to make the explicit distinction between perceived controllability and self-efficacy and propose
17 specific hypotheses regarding the role of each factor in mediating the effects of autonomous
18 motivation for mathematics homework on intentions to engage in mathematics homework in
19 future.

20 We also found a statistically significant and positive effect of the autonomous forms of
21 motivation on subjective norms. We hypothesized a negative relation because subjective norms
22 reflects beliefs regarding social pressure to act and are, therefore, consistent with controlled
23 motivation and inconsistent with autonomous motivation. A possible reason for the positive
24 effect is that normative beliefs with respect to homework represent students' internalized
25 beliefs regarding salient others' expectations (e.g., teachers, parents). According to self-
26 determination theory, internalization is the process by which individuals view the demands and

1 instructions of salient others as important to their goals instead of controlling (Ryan, 1995).
2 Internalization, therefore, reflects individuals' choice to adhere to the commands of significant
3 others and, therefore, *autonomously* decide to conform (Deci, Eghrari, Patrick, & Leone, 1994;
4 Ryan & Connell, 1989). Students in the current study, therefore, may have internalized salient
5 others' demands to complete their homework and viewed the demands as supportive of their
6 autonomous motivation. This finding could represent a modification or caveat to the trans-
7 contextual model and future research may seek to distinguish between autonomous and
8 controlled normative beliefs similar to the same distinction made by Chatzisarantis et al. (1997;
9 2007; 2006) for intentions. Finally, subjective norms were also a significant positive direct
10 predictor of mathematics homework outcomes. This is contrary to the hypotheses of the trans-
11 contextual model and the theory of planned behavior. To speculate, this path may be explained
12 by unmeasured norm-related mediators which account for the motivational effects of subjective
13 norms of behavior more effectively than intentions. It may also reflect more spontaneous,
14 automatic participation in the behavior due to the influence of significant others mitigating the
15 need to deliberate over acting (Hagger et al., 2006; Trafimow & Finlay, 1996).

16 Overall, our findings provide preliminary evidence that school students that report
17 autonomous motivation among toward the activities they perform in their mathematics lessons
18 are more likely to be autonomous motivated toward their mathematics homework they do in
19 out-of-school contexts, are more likely to hold beliefs and intentions consistent with those
20 motives toward future engagement in mathematics homework, and are more likely to report
21 having engaged in mathematics homework outcomes. This means that mathematics teachers
22 who are able to support students' autonomous motivation in class are also likely to foster
23 autonomous motivation outside of school. One way to do this is to promote in autonomy-
24 supportive behaviors among mathematics teachers in their lessons (Reeve & Jang, 2006). The
25 link between perceived autonomy support and autonomous motivation toward mathematics
26 activities in the educational context in the current research indicates the potential effectiveness

1 that autonomy supportive behaviors could have on students' motivation. This is important
2 because one of the key goals of education is to foster self-directed learning in students, which
3 means they are more likely to persist with self-directed learning activities (e.g., homework) in
4 the absence of extrinsic reinforcing agents (Deci et al., 1991; Reeve, 2002). The trans-
5 contextual model may therefore provide the basis for interventions that promote transfer of
6 motivation from educational to out-of-school contexts (Chatzisarantis & Hagger, 2009; Yli-
7 Piipari, Layne, & Irwin, 2014).

8 **5. Conclusions**

9 Current findings provide preliminary evidence that students' perceptions of what their
10 teachers say and do in mathematics classes affect their motivation toward learning activities in
11 class and their motivation toward learning outside of school. Strengths of the current research
12 include the adoption of an appropriate multi-theory approach and its application in a unique
13 context, and the use of a prospective three-wave design, validated measures, and appropriate
14 measures of students' mathematics homework engagement and attainment. The study is not
15 without limitations and we briefly outline a few here. First, our prospective design limits the
16 extent to which we can infer causality (Hagger & Chatzisarantis, 2009a). Future research
17 should seek to engage in experimental tests that may further elucidate the causal relations
18 inferred in the model (Bagozzi, 2010). Second, we did not account for all sources of autonomy
19 support in our model and future studies should also evaluate the importance of parental support
20 for autonomy toward mathematics homework outcomes (Hagger et al., 2009). Related to this, it
21 might be interesting to measure and control for the effects of teachers' other education-related
22 behaviors beyond the autonomy-support techniques specified in the trans-contextual model.
23 Third, we did not include measures of basic psychological need satisfaction in our current
24 study. Need satisfaction may be a determinant autonomous motivation in educational contexts
25 and out-of-school contexts (Barkoukis et al., 2010), but may also serve to mediate effects of
26 perceived autonomy support on autonomous motivation. We look to future studies to test this

1 mediation hypothesis in mathematics education. Fourth, there is a need to replicate current
2 findings to further confirm the generalizability of model predictions, consistent with recent
3 work replicating the model in multiple academic contexts (e.g., Chan et al., 2015; Hagger,
4 Sultan, Hardcastle, & Chatzisarantis, 2015) and behavioral contexts (e.g., Chan & Hagger,
5 2012). Fifth, testing proposed model effects on other education-related outcomes, and the role
6 that other moderating and mediating variables might play in the model, would be fruitful
7 avenues for future research.

References

- Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50, 179-211. doi: 10.1016/0749-5978(91)90020-T
- Ajzen, I. (2002). Perceived behavioral control, self-efficacy, locus of control, and the theory of planned behavior. *Journal of Applied Social Psychology*, 32, 1-20.
- Ajzen, I. (2003, April 14, 2003). Constructing a TPB questionnaire: Conceptual and methodological considerations. Retrieved April 1, 2003, from <http://www-unix.oit.umass.edu/~ajzen>
- Ajzen, I. (2015). The theory of planned behavior is alive and well, and not ready to retire. *Health Psychology Review*. Advance online publication. doi: 10.1080/17437199.2014.883474
- Armitage, C. J., & Conner, M. (1999). Distinguishing perceptions of control from self-efficacy: Predicting consumption of a low fat diet using the Theory of Planned Behavior. *Journal of Applied Social Psychology*, 29, 72-90. doi: 10.1111/j.1559-1816.1999.tb01375.x
- Bagozzi, R. P. (2010). Structural equation models are modelling tools with many ambiguities: Comments acknowledging the need for caution and humility in their use. *Journal of Consumer Psychology*, 20, 208-214. doi: 10.1016/j.jcps.2010.03.001
- Bagozzi, R. P., & Warshaw, P. R. (1990). Trying to consume. *Journal of Consumer Research*, 17, 127-140. doi: 10.1086/208543
- Barkoukis, V., Hagger, M. S., Lambropoulos, G., & Torbatzoudis, H. (2010). Extending the trans-contextual model in physical education and leisure-time contexts: Examining the role of basic psychological need satisfaction. *British Journal of Educational Psychology*, 80, 647-670. doi: 10.1348/000709910X487023
- Chan, D. K. C., & Hagger, M. S. (2012). Autonomous forms of motivation underpinning injury prevention and rehabilitation among police officers: An application of the trans-contextual model. *Motivation and Emotion*, 36, 349-364. doi: 10.1007/s11031-011-9247-4
- Chan, D. K. C., Yang, S. X., Hamamura, T., Sultan, S., Xing, S., Chatzisarantis, N. L. D., & Hagger, M. S. (2015). In-lecture learning motivation predicts students' motivation, intention, and behaviour for after-lecture learning: Examining the trans-contextual model across universities from UK, China, and Pakistan. *Motivation and Emotion*. Advance online publication. doi: 10.1007/s11031-015-9506-x
- Chatzisarantis, N. L. D., Biddle, S. J. H., & Meek, G. A. (1997). A self-determination theory approach to the study of intentions and the intention-behaviour relationship in children's physical activity. *British Journal of Health Psychology*, 2, 343-360.
- Chatzisarantis, N. L. D., & Hagger, M. S. (2009). Effects of an intervention based on self-determination theory on self-reported leisure-time physical activity participation. *Psychology and Health*, 24, 29-48. doi: 10.1080/08870440701809533
- Chatzisarantis, N. L. D., Hagger, M. S., & Smith, B. (2007). Influences of perceived autonomy support on physical activity within the theory of planned behavior. *European Journal of Social Psychology*, 37, 934-954. doi: 10.1002/ejsp.407
- Chatzisarantis, N. L. D., Hagger, M. S., Smith, B., & Sage, L. D. (2006). The influences of intrinsic motivation on execution of social behaviour within the theory of planned behaviour. *European Journal of Social Psychology*, 36, 229-237. doi: 10.1002/ejsp.299
- Deci, E. L., Eghrari, H., Patrick, B. C., & Leone, D. R. (1994). Facilitating internalization: The self-determination theory perspective. *Journal of Personality*, 62, 119-142. doi: 10.1111/j.1467-6494.1994.tb00797.x
- Deci, E. L., & Ryan, R. M. (2000). The "What" and "Why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry*, 11, 227-268. doi: 10.1207/S15327965PLI1104_01

- Deci, E. L., Vallerand, R. J., Pelletier, L. G., & Ryan, R. M. (1991). Motivation in education: The self-determination perspective. *Educational Psychologist*, *26*, 325-346. doi: 10.1080/00461520.1991.9653137
- Diamantopoulos, A., & Sigauw, J. A. (2000). *Introducing LISREL*. Thousand Oaks, CA: Sage.
- Ferguson, Y. L., Kasser, T., & Jahng, S. (2011). Differences in life satisfaction and school satisfaction among adolescents from three nations: The role of perceived autonomy support. *Journal of Adolescence*, *21*, 649-661. doi: 10.1111/j.1532-7795.2010.00698.x
- González-Cutre, D., Sicilia, Á., Beas-Jiménez, M., & Hagger, M. S. (2014). Broadening the trans-contextual model of motivation: A study with Spanish adolescents. *Scandinavian Journal of Science and Medicine in Sport*, *24*, e306-e319. doi: 10.1111/sms.12142
- Guay, F., Boggiano, A. K., & Vallerand, R. J. (2001). Autonomy support, motivation, and perceived competence: Conceptual and empirical linkages. *Personality and Social Psychology Bulletin*, *27*, 643-650. doi: 10.1177/0146167201276001
- Hagger, M. S., & Chatzisarantis, N. L. D. (2009a). Assumptions in research in sport and exercise psychology. *Psychology of Sport and Exercise*, *10*, 511-519. doi: 10.1016/j.psychsport.2009.01.004
- Hagger, M. S., & Chatzisarantis, N. L. D. (2009b). Integrating the theory of planned behaviour and self-determination theory in health behaviour: A meta-analysis. *Psychology and Health*, *24*, 39-39.
- Hagger, M. S., & Chatzisarantis, N. L. D. (2012). Transferring motivation from educational to extramural contexts: A review of the trans-contextual model. *European Journal of Psychology of Education*, *27*, 195-212. doi: 10.1007/s10212-011-0082-5
- Hagger, M. S., & Chatzisarantis, N. L. D. (2015). The trans-contextual model of autonomous motivation in education: Conceptual and empirical issues and meta-analysis. *Review of Educational Research*. doi: 10.3102/0034654315585005
- Hagger, M. S., Chatzisarantis, N. L. D., Barkoukis, V., Wang, C. K. J., & Baranowski, J. (2005). Perceived autonomy support in physical education and leisure-time physical activity: A cross-cultural evaluation of the trans-contextual model. *Journal of Educational Psychology*, *97*, 376-390. doi: 10.1037/0022-0663.97.3.376
- Hagger, M. S., Chatzisarantis, N. L. D., & Biddle, S. J. H. (2001). The influence of self-efficacy and past behaviour on the physical activity intentions of young people. *Journal of Sports Sciences*, *19*, 711-725. doi: 10.1080/02640410152475847
- Hagger, M. S., Chatzisarantis, N. L. D., Culverhouse, T., & Biddle, S. J. H. (2003). The processes by which perceived autonomy support in physical education promotes leisure-time physical activity intentions and behavior: A trans-contextual model. *Journal of Educational Psychology*, *95*, 784-795. doi: 10.1037/0022-0663.95.4.784
- Hagger, M. S., Chatzisarantis, N. L. D., & Harris, J. (2006). From psychological need satisfaction to intentional behavior: Testing a motivational sequence in two behavioral contexts. *Personality and Social Psychology Bulletin*, *32*, 131-138. doi: 10.1177/0146167205279905
- Hagger, M. S., Chatzisarantis, N. L. D., Hein, V., Pihu, M., Soós, I., & Karsai, I. (2007). The perceived autonomy support scale for exercise settings (PASSSES): Development, validity, and cross-cultural invariance in young people. *Psychology of Sport and Exercise*, *8*, 632-653. doi: 10.1016/j.psychsport.2006.09.001
- Hagger, M. S., Chatzisarantis, N. L. D., Hein, V., Pihu, M., Soós, I., Karsai, I., . . . Leemans, S. (2009). Teacher, peer, and parent autonomy support in physical education and leisure-time physical activity: A trans-contextual model of motivation in four cultures. *Psychology and Health*, *24*, 689-711. doi: 10.1080/08870440801956192
- Hagger, M. S., Sultan, S., Hardcastle, S. J., & Chatzisarantis, N. L. D. (2015). Perceived autonomy support and autonomous motivation toward mathematics activities in educational and out-of-school contexts is related to mathematics homework behavior

- and attainment. *Contemporary Educational Psychology*, *41*, 111–123. doi: 10.1016/j.cedpsych.2014.12.002
- Hodgen, J., Kuchemann, D., Brown, M., & Coe, R. (2009). School students' understandings of algebra 30 years on. In M. Tzekaki, M. Kaldrimidou & H. Sakonidis (Eds.), *Proceedings of the 33rd Conference of the International Group for the Psychology of Mathematics Education* (Vol. 3, pp. 177-184). Prague: International Group for the Psychology of Mathematics Education.
- Jackson, B., Whipp, P. R., Chua, K. L. P., Dimmock, J. A., & Hagger, M. S. (2013). Students' tripartite efficacy beliefs in high school physical education: Within- and cross-domain relations with motivational processes and leisure-time physical activity outcomes. *Journal of Sport & Exercise Psychology*, *35*, 72-84.
- Kock, N. (2012). *WarpPLS v. 3.0 Nonlinear structural equation modeling made easy*. Laredo, TX: ScriptWarp Systems.
- Kock, N. (2013). *WarpPLS 4.0 User Manual*. Laredo, TX: ScriptWarp Systems.
- Koestner, R., Bernieri, F., & Zuckerman, M. (1992). Self-regulation and consistency between attitudes, traits, and behaviors. *Personality and Social Psychology Bulletin*, *18*, 52-59. doi: 10.1177/0146167292181008
- McLachlan, S., & Hagger, M. S. (2010a). Associations between motivational orientations and chronically-accessible outcomes in leisure-time physical activity: Are appearance-related outcomes controlling in nature? *Research Quarterly for Exercise and Sport*, *81*, 102-107. doi: 10.1080/02701367.2010.10599633
- McLachlan, S., & Hagger, M. S. (2010b). Effects of an autonomy-supportive intervention on tutor behaviors in a higher education context. *Teaching and Teacher Education*, *26*, 1205-1211. doi: 10.1016/j.tate.2010.01.006
- McLachlan, S., & Hagger, M. S. (2011a). Do people differentiate between intrinsic and extrinsic goals in physical activity behavior? *Journal of Sport & Exercise Psychology*, *33*, 273-288.
- McLachlan, S., & Hagger, M. S. (2011b). The influence of chronically-accessible autonomous and controlling motives on physical activity within an extended theory of planned behaviour. *Journal of Applied Social Psychology*, *41*, 445-470. doi: 10.1111/j.1559-1816.2010.00721.x
- NCES. (2012). *Highlights from TIMSS 2011: Mathematics and science achievement of U.S. fourth- and eighth-grade students in an international context*. Washington, DC: National Center for Education Statistics, Institute of Education Sciences (IES).
- Pintrich, P. R., & Degroot, E. V. (1990). Motivational and self-regulated learning components of classroom academic-performance. *Journal of Educational Psychology*, *82*, 33-40. doi: 10.1037/0022-0663.82.1.33
- Reeve, J. (2002). Self-determination theory applied to educational settings. In E. L. Deci & R. M. Ryan (Eds.), *Handbook of self-determination research* (pp. 183-203). Rochester, NY: University of Rochester Press.
- Reeve, J., Bolt, E., & Cai, Y. (1999). Autonomy-supportive teachers: How they teach and motivate students. *Journal of Educational Psychology*, *91*, 537-548. doi: 10.1037/0022-0663.91.3.537
- Reeve, J., & Jang, H. (2006). What teachers say and do to support students' autonomy during a learning activity. *Journal of Educational Psychology*, *98*, 209-218. doi: 10.1037/0022-0663.98.1.209
- Ryan, R. M. (1995). Psychological needs and the facilitation of integrative processes. *Journal of Personality*, *63*, 397-427. doi: 10.1111/j.1467-6494.1995.tb00501.x
- Ryan, R. M., & Connell, J. P. (1989). Perceived locus of causality and internalization: Examining reasons for acting in two domains. *Journal of Personality and Social Psychology*, *57*, 749-761. doi: 10.1037/0022-3514.57.5.749

- Shen, B., McCaughtry, N., & Martin, J. (2008). Urban adolescents' exercise intentions and behaviors: An exploratory study of a trans-contextual model. *Contemporary Educational Psychology, 33*, 841-858. doi: 10.1016/j.cedpsych.2007.09.002
- Standage, M., Gillison, F. B., Ntoumanis, N., & Treasure, D. C. (2012). Predicting students' physical activity and health-related well-being: A prospective cross-domain investigation of motivation across school physical education and exercise settings. *Journal of Sport & Exercise Psychology, 34*, 37-60.
- Steinmayr, R., & Spinath, B. (2009). The importance of motivation as a predictor of school achievement. *Learning and Individual Differences, 19*, 80-90. doi: 10.1016/j.lindif.2008.05.004
- Tenenhaus, M., Vinzi, V. E., Chatelin, Y.-M., & Lauro, C. (2005). PLS path modeling. *Computational Statistics & Data Analysis, 48*, 159-205. doi: 10.1016/j.csda.2004.03.005
- Terry, D. J., & O'Leary, J. E. (1995). The Theory of Planned Behaviour: The effects of perceived behavioural control and self-efficacy. *British Journal of Social Psychology, 34*, 199-220. doi: 10.1111/j.2044-8309.1995.tb01058.x
- Trafimow, D., & Finlay, K. A. (1996). The importance of subjective norms for a minority of people: Between-subjects and within-subjects effects. *Personality and Social Psychology Bulletin, 22*, 820-828.
- Trautwein, U. (2007). The homework–achievement relation reconsidered: Differentiating homework time, homework frequency, and homework effort. *Learning and Instruction, 17*, 372-388. doi: 10.1016/j.learninstruc.2007.02.009
- Vallerand, R. J. (1991). Motivation and education: The self-determination perspective. *Educational Psychologist, 26*, 325-346. doi: 10.1207/s15326985ep2603&4_6
- Vallerand, R. J. (1997). Towards a hierarchical model of intrinsic and extrinsic motivation. *Advances in Experimental Social Psychology, 29*, 271-360. doi: 10.1016/S0065-2601(08)60019-2
- Vallerand, R. J. (2000). Deci and Ryan's Self-Determination Theory: A view from the hierarchical model of intrinsic and extrinsic motivation. *Psychological Inquiry, 11*, 312-318. doi: 10.1207/S15327965PLI1104_02
- Vallerand, R. J. (2007). A hierarchical model of intrinsic and extrinsic motivation for sport and physical activity. In M. S. Hagger & N. L. D. Chatzisarantis (Eds.), *Intrinsic Motivation and Self-Determination in Exercise and Sport* (pp. 255-279). Champaign, IL: Human Kinetics.
- Yli-Piipari, S., Layne, T., & Irwin, C. (2014). *An autonomy-supportive intervention on physical education motivation and physical activity*. Paper presented at the Alliance for Health, Physical Education, Recreation and Dance National (AAHPERD) Convention, St Louis, MO.

Table 1

Summary of Hypothesized Direct and Indirect Effects in the Trans-Contextual Model

Hypothesis	Independent variable	Dependent variable	Mediator(s)	Prediction ^a
Direct Effects				
H ₁	Perceived autonomy support	Autonomous motivation (s)	–	Effect (+)
H ₂	Autonomous motivation (s)	Autonomous motivation (h)	–	Effect (+)
H ₃	Autonomous motivation (h)	Attitude	–	Effect (+)
H ₄	Autonomous motivation (h)	PBC	–	Effect (+)
H ₅	Autonomous motivation (h)	Subjective norms	–	Effect (–)
H ₆	Autonomous motivation (s)	Attitude	–	No effect
H ₇	Autonomous motivation (s)	PBC	–	No effect
H ₈	Autonomous motivation (s)	Subjective norms	–	No effect
H ₉	Attitude	Intention	–	Effect (+)
H ₁₀	Subjective norms	Intention	–	Effect (+)
H ₁₁	PBC	Intention	–	Effect (+)
H ₁₂	Intention	Mathematics homework outcomes	–	Effect (+)
H ₁₃	Attitude	Mathematics homework outcomes	–	No effect
H ₁₄	Subjective norms	Mathematics homework outcomes	–	No effect
H ₁₅	PBC	Mathematics homework outcomes	–	Effect (+)
H ₁₆	Perceived autonomy support	Intention	–	No effect
H ₁₇	Perceived autonomy support	Mathematics homework outcomes	–	No effect
Indirect effects				
H ₁₈	Perceived autonomy support	Autonomous motivation (h)	Autonomous motivation (s)	Effect (+)
H ₁₉	Autonomous motivation (s)	Intention	Autonomous motivation (h) Attitude	Effect (+)
H ₂₀	Autonomous motivation (s)	Intention	Autonomous motivation (h) PBC	Effect (+)
H ₂₁	Autonomous motivation (s)	Mathematics homework outcomes	Autonomous motivation (h) Attitude Intention	Effect (+)
H ₂₂	Autonomous motivation (s)	Mathematics homework outcomes	Autonomous motivation (h) PBC Intention	Effect (+)
H ₂₃	Autonomous motivation (h)	Intention	Attitude	Effect (+)
H ₂₄	Autonomous motivation (h)	Intention	PBC	Effect (+)
H ₂₅	Autonomous motivation (h)	Mathematics homework outcomes	Attitude Intention	Effect (+)
H ₂₆	Autonomous motivation (h)	Mathematics homework outcomes	PBC Intention	Effect (+)
H ₂₇	Perceived autonomy support	Mathematics homework outcomes	Autonomous motivation (s) Autonomous motivation (h) Intention antecedents Intention	Effect (+)

RUNNING HEAD: The Trans-Contextual Model and Mathematics Homework

Note. s = school or educational context; h = home or out-of-school context; PBC = perceived behavioral control. ^aDenotes whether the hypothesis specifies a positive (+) effect, a negative (–) effect, or no effect.

Table 2

Goodness-of-Fit Indices for the Partial Least Squares Structural Equation Model of the Trans-Contextual Model

Index	Criterion	Statistic
Tenenhous et al. (2005) goodness-of-fit index	.100, .250, and .360 correspond to small, medium, and large effect sizes	.417
APC	Should be significantly different from zero	.187 ($p < .001$)
ARS	Should be significantly different from zero	.251, $p < 0.001$
AVIF	Less than 5.000 indicates well-fitting model	1.744

Note. APC = Average path coefficient; ARS = Average R^2 ; AVIF = Average variance inflation factor.

Table 3
Measurement Model Statistics and Factor Intercorrelations for Trans-Contextual Model Latent Variables

Variable	ρ	AVE	FCVIF	R^2	1	2	3	4	5	6	7	8	9
1. Perceived autonomy support (school)	.887	.391	1.163	.014	(.625)								
2. Autonomous motivation (school)	.927	.809	1.406	.145	.314***	(.899)							
3. Autonomous motivation (homework)	.908	.768	1.607	.206	.137*	.427***	(.876)						
4. Attitude	.872	.578	2.797	.282	.220***	.366***	.441***	(.760)					
5. Subjective norm	.711	.455	1.859	.202	.042	.225***	.355***	.116	(.674)				
6. Perceived behavioral control	.805	.673	1.244	.061	-.120	-.066	-.092	-.310***	.238***	(.821)			
7. Intention	.863	.679	2.775	.633	.258***	.306***	.471***	.770***	.185*	-.250***	(.824)		
8. Mathematics homework outcomes	.961	.892	1.688	.252	.078	.194**	.235***	.213***	.582***	.001	.289***	(.945)	
9. Past homework effort	–	–	1.152	–	.094	.148*	.067	.181**	.226***	.054	.105	.289***	(1.000)

Note. ρ = Composite reliability coefficient; AVE = Average variance extracted; FCVIF = full colinearity variance inflation factor; Values on principal diagonal are square-root of average variance extracted (AVE).

*** $p < .001$ ** $p < .01$ * $p < .05$.

Figure captions

Figure 1. The Hypothesized Trans-Contextual Model.

Note.

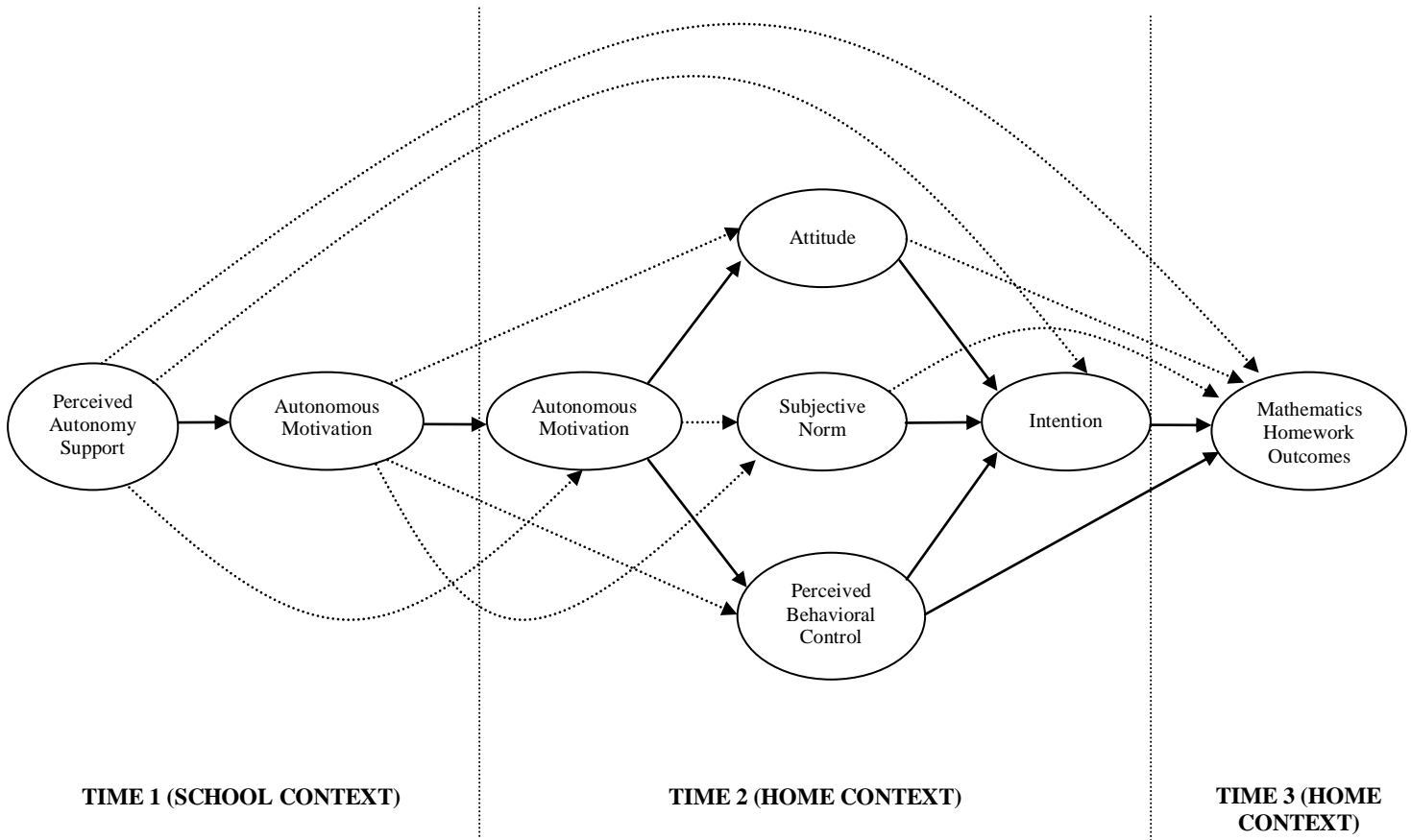
Broken lines between constructs indicate direct effects proposed to be non-significant or unsubstantial relative to the indirect effects.

Figure 2. Standardized Path Coefficients for Structural Equation Model of Hypothesized Relations among Trans-Contextual Model Constructs.

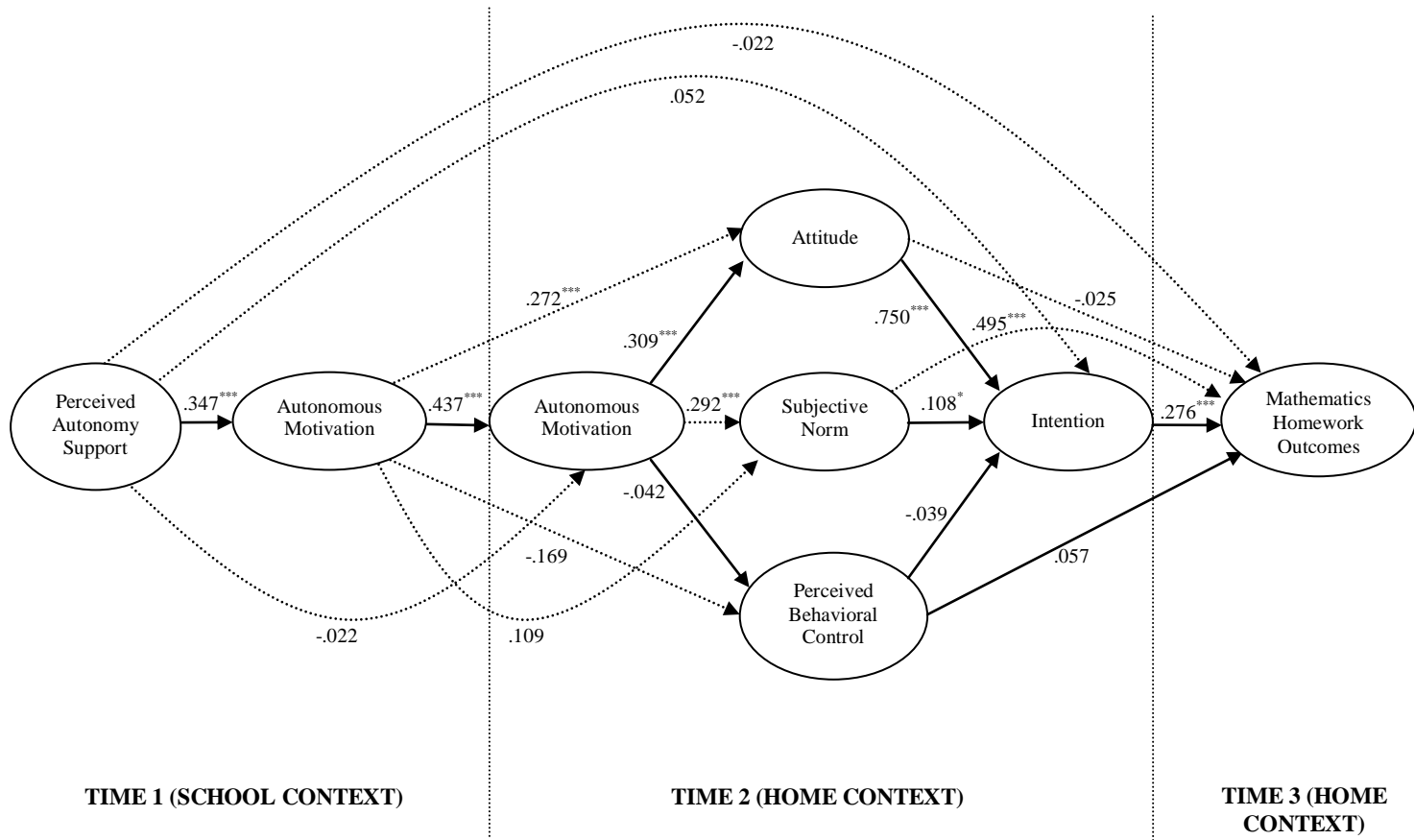
Note.

Effects of past mathematics effort on each variable in the model omitted for clarity: past mathematics effort→perceived autonomy support, $\beta = .118, p = .094$; past mathematics effort→autonomous motivation (school context), $\beta = .123, p = .029$; past mathematics effort→autonomous motivation (home context), $\beta = .107, p = .248$; past mathematics effort→attitude, $\beta = .150, p = .006$; past mathematics effort→subjective norms, $\beta = .239, p < .001$; past mathematics effort→perceived behavioral control, $\beta = .159, p = .196$; past mathematics effort→intention, $\beta = .029, p = .258$; past mathematics effort→mathematics homework outcomes, $\beta = .377, p < .001$.

RUNNING HEAD: The Trans-Contextual Model and Mathematics Homework



RUNNING HEAD: The Trans-Contextual Model and Mathematics Homework



RUNNING HEAD: The Trans-Contextual Model and Mathematics Homework

Appendix A. Details of Measures Used in Trans-Contextual Model (Online Supplemental Material)

Measure	Subscale (if applicable)	Detail	Scale (if applicable)	
Perceived autonomy support for mathematics by teachers		I feel that my maths teacher provides me with choices and options when doing activities in maths lessons	1 = Strongly agree, 7 = Strongly disagree	
		I feel understood by my maths teacher when doing activities in maths lessons		
		I feel I am able to be open with my maths teacher when doing activities in maths lessons		
		My maths seemed confident in my ability to do well when doing activities in maths lessons		
		I feel my maths teacher accepts me when doing activities in maths lessons		
		My maths teacher made sure I really understood the goals of the maths lessons and what I need to do		
		My maths teacher encourages me to ask questions when doing activities in maths lessons		
		I feel a lot of trust in my maths teacher when doing activities in maths lessons		
		My maths teacher answers my questions fully and carefully when doing activities in maths lessons		
		My maths teacher listens to how I would like to do things when doing activities in maths lessons		
Perceived locus of causality (school)	Intrinsic motivation	Stem: I do maths exercises and solve maths problems in my maths lessons because...	1 = Not true at all, 4 = Very true	
		...maths exercises and problems are enjoyable		
		...I enjoy learning new skills		
		... maths is fun		
		Identified regulation		... it is important to me to do well in maths
				... it is important to me to improve in the exercises and problems we do in maths lessons
				... it is important to me to try to solve maths problems
		Introjected regulation		... I would feel bad about myself if I didn't
				... I would feel bad if the other students thought that I was not good at maths
				... it would bother me if I didn't
External regulation	...so that the teacher won't yell at me			
	...that's the rule			
	...this way I will not get a low grade			
Perceived locus of causality (homework)	Intrinsic motivation	Stem: I do maths homework because...	1 = Not true at all, 4 = Very true	
		...maths exercises and problems are enjoyable		
		...I enjoy doing maths homework		
		...doing maths homework is an important part of my life		
		Identified regulation		... I value the benefits of doing maths homework
				... I think it is important to make the effort to do my maths homework
				...it is important to me to do my maths homework
		Introjected regulation		... I will feel bad with myself if I do not
				... people I know well (e.g., friend, parents etc.) say I should
				... I feel like a failure when I have not done my maths homework
External regulation	...others will be displeased with me if I do not			
	...I feel under pressure from people I know well (e.g., friends, parents etc.)			
	...doing my maths homework is something that I should do			
Theory of planned behavior	Intention	I plan to do my maths homework set by my teacher at home over the next 5 weeks	1 = Unlikely, 7 = Very likely	
		I plan to do my maths homework set by my teacher at home over the next 5 weeks with the following regularity		
		I want to do my maths homework set by my teacher at home over the next 5 weeks		

RUNNING HEAD: The Trans-Contextual Model and Mathematics Homework

Attitudes	Stem: Doing my maths homework at home over the next 5 weeks will be... Unenjoyable – enjoyable Bad – good Useless – useful Boring – interesting Harmful – beneficial	Seven-point semantic differential scales
-----------	---	--

Subjective norms	Most people who are important to me think that I should do maths homework at home over the next 5 weeks Most people who are important to me put pressure on me to do maths homework at home over the next 5 weeks Significant others like parents, family, and friends want me to do my maths homework at home over the next 5 weeks	1 = Strongly disagree, 7 = Strongly agree
---------------------	--	---

Perceived behavioral control	I have control over doing my maths homework over the next 5 weeks I am confident I could do my maths homework at home over the next 5 weeks I feel in complete control over whether I will do my maths homework at home over the next 5 weeks	1 = Strongly disagree, 7 = Strongly agree
------------------------------------	---	---

Mathematics homework engagement	Over the last five weeks how often have you done your maths homework? How frequently did you do your maths homework in the last five weeks?	1 = Not at all, 7 = All of the time
---------------------------------------	--	--

Mathematics homework grades	Student's average grade on completed homework assignments (range = 8 to 10 completed assignments per student), M grade = 63.21, SD = 27.33	
-----------------------------------	--	--

Past effort on mathematics homework	How much did you try to do your maths homework during the last 5 weeks?	1 = I didn't try at all, 7 = I tried very hard
---	---	---

Online supplemental material

Details of Measures Used to Tap Trans-Contextual Model Components

Scale	Subscale	Items	Scale anchors
Perceived autonomy support for maths by teachers		I feel that my maths teacher provides me with choices and options when doing activities in maths lessons	1 = strongly agree, 7 = strongly disagree
		I feel understood by my maths teacher when doing activities in maths lessons	
		I feel I am able to be open with my maths teacher when doing activities in maths lessons	
		My maths seemed confident in my ability to do well when doing activities in maths lessons	
		I feel my maths teacher accepts me when doing activities in maths lessons	
		My maths teacher made sure I really understood the goals of the maths lessons and what I need to do	
		My maths teacher encourages me to ask questions when doing activities in maths lessons	
		I feel a lot of trust in my maths teacher when doing activities in maths lessons	
		My maths teacher answers my questions fully and carefully when doing activities in maths lessons	
		My maths teacher listens to how I would like to do things when doing activities in maths lessons	
		I feel that my maths teacher cares about me as a person in maths lessons	
		My maths teacher tries to understand how I see things before suggesting a new way to do activities in maths lessons	
	Perceived locus of causality (school)	Intrinsic motivation	
...maths exercises and problems are enjoyable			
...I enjoy learning new skills			
... maths is fun			
Identified regulation		... I would feel bad about myself if I didn't	
		... I would feel bad if the other students thought that I was not good at maths	
		... it would bother me if I didn't	
Introjected regulation		... it is important to me to do well in maths	
		... it is important to me to improve in the exercises and problems we do in maths lessons	
		... it is important to me to try to solve maths problems	
External regulation		...so that the teacher won't yell at me	
		...that's the rule	
	...this way I will not get a low grade		
Perceived locus of causality (homework)	Intrinsic motivation	Stem: I do maths homework because...	1 = “not true at all”, 4 = “very true”
		...maths exercises and problems are enjoyable	
		...I enjoy doing maths homework	
		...doing maths homework is an important part of my life	
	Identified regulation	... I value the benefits of doing maths homework	
		... I think it is important to make the effort to do my maths homework	
		...it is important to me to do my maths homework	
	Introjected regulation	... I will feel bad with myself if I do not	
		... people I know well (e.g., friend, parents etc.) say I should	
		... I feel like a failure when I have not done my maths homework	

	External regulation	<p>...others will be displeased with me if I do not</p> <p>...I feel under pressure from people I know well (e.g., friends, parents etc.)</p> <p>...doing my maths homework is something that I should do</p>	
Theory of planned behavior	Intention	<p>I plan to do my maths homework set by my teacher at home over the next 5 weeks</p> <p>I plan to do my maths homework set by my teacher at home over the next 5 weeks with the following regularity</p> <p>I want to do my maths homework set by my teacher at home over the next 5 weeks</p>	1 = Unlikely, 7 = Very likely
Theory of planned behavior	Attitudes	<p>Stem: Doing my maths homework at home over the next 5 weeks will be...</p> <p>Unenjoyable – enjoyable</p> <p>Bad – good</p> <p>Useless – useful</p> <p>Boring – interesting</p> <p>Harmful – beneficial</p>	Seven-point semantic differential scales
	Subjective norms	<p>Most people who are important to me think that I should do maths homework at home over the next 5 weeks</p> <p>Most people who are important to me put pressure on me to do maths homework at home over the next 5 weeks</p> <p>Significant others like parents, family, and friends want me to do my maths homework at home over the next 5 weeks</p>	1 = Strongly disagree, 7 = Strongly agree
	Perceived behavioral control	<p>I have control over doing my maths homework over the next 5 weeks</p> <p>I am confident I could do my maths homework at home over the next 5 weeks</p> <p>I feel in complete control over whether I will do my maths homework at home over the next 5 weeks</p>	1 = Strongly disagree, 7 = Strongly agree
Maths homework engagement		<p>Over the last five weeks how often have you done your maths homework</p> <p>How frequently did you do your maths homework in the last five weeks</p>	1 = Not at all, 7 = All of the time
Past effort on maths homework		How much did you try to do your maths homework during the last 5 weeks?	1 = I didn't try at all, 7 = I tried very hard