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

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FULL CITATION: Hagger, M. S., Sultan, S., Hardcastle, S. J., Reeve, J., Patall, E. A., Fraser, B. J., Hamilton, K., & Chatzisarantis, N. L. D. (2016). Applying the trans-contextual model to mathematics activities in the classroom and homework behaviour and attainment. *Learning and Individual Differences, 45,* 166–175. doi: 10.1016/j.lindif.2015.11.017

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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

1. Introduction

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

1.1. The trans-contextual model

The trans-contextual model outlines the process by which school students' autonomous motivation toward activities in an educational context is transferred to autonomous motivation, and intentions and future engagement in educational activities outside of school (Hagger, Chatzisarantis, Culverhouse, & Biddle, 2003). Model hypotheses are summarized in Figure 1 and Table 1[1]. A central premise of the trans-contextual model is that autonomous forms of motivation are adaptive and lead to increased persistence on tasks without the need for any externally-referenced contingency. Autonomous motivation is defined as acting for reasons of interest and enjoyment in the belief that the self is the origin of the behavior. Autonomous motivation is contrasted with controlled motivation, defined as acting out of externally-referenced obligation or reinforcement and leads to behavioral persistence only as long as the external contingency is present. Promoting autonomous forms of motivation in educational contexts is considered adaptive as it has been linked with higher levels of persistence on educational tasks (Reeve et al., 1999). Teachers can foster greater autonomous motivation by adopting autonomy-supportive styles that promote students' interest and self-directed learning. Students' perceived autonomy support serves as a proxy measure teachers' autonomy support. The link between perceived autonomy support and autonomous motivation toward activities in educational contexts forms the first hypothesis of the trans-contextual model. School students' perceived autonomy support from teachers with respect to classroom educational activities is expected to be associated with their autonomous motivation (H_1) in the classroom.

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

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

different context to the educational context, such as performing educational activities (e.g., mathematics homework) in an out-of-school context (e.g., home), will likely activate the 'script' or schema for mathematics activity engagement so that it serves as a guide or template for motivational responses and linked patterns of action in that context (Vallerand, 2000). Based on this mechanism, autonomous motivation toward mathematics activities in the educational context is proposed in the model to be related to autonomous motivation toward mathematics homework in the out-of-school context (H_2).

The trans-contextual model also proposes that autonomous forms of motivation toward mathematics activities out-of-school contexts will be related to beliefs and intentions regarding engagement in those activities in the future. The trans-contextual model integrates the theory of planned behavior (Ajzen, 1991, 2015) to delineate relations between autonomous motivation, beliefs about engaging in behavior, and intentions and future behavioral enactment. According to the theory, *behavioral intention*, a motivational variable that reflects the degree of planning and effort an individual is likely to invest in pursuing a given behavior, is the proximal determinant of behavior. Behavioral intention is a function of *attitudes*, an individual's positive or negative evaluation of engaging in a future target behavior, *subjective norms*, beliefs that social agents pressurize one into engaging in the behavior, and *perceived behavioral control*, beliefs regarding personal capacity to engage in the behavior. Intentions are hypothesized to mediate effects of attitudes, subjective norms and perceived behavioral control on actual behavior (Ajzen, 1991, 2015). Consistent with self-determination theory, individuals are compelled to satisfy their psychological needs and need satisfaction will engender autonomous motivation to engage in specific behaviors likely to be need satisfying (Hagger, Chatzisarantis, & Harris, 2006). As a consequence, individuals will tend to align their attitudes, perceived control, and intentions with their autonomous motives, a strategic response as it will prepare the individual to engage in autonomously-motivated behaviors in future (Deci & Ryan, 2000; Koestner, Bernieri, & Zuckerman, 1992). The inclusion of beliefs and intentions from the theory of planned behavior therefore provides a means of testing the process by which contextual-level motives lead to future behavior. The distinction between autonomous motivation as generalized motives toward a behavior and intentions and other constructs from the theory of planned behavior as specific beliefs regarding future action is reflected in the measures used to tap these constructs.

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

Focusing on the proximal belief-based antecedents of the theory of planned behavior, intentions are hypothesized to be a function of attitudes (H_9), perceived behavioral control (H_{10}), and subjective norms (H_{11}). Intentions are hypothesized to be a direct predictor of mathematics homework outcomes (H_{12}) and the direct effects of the attitude (H_{13}) and subjective norms (H_{14}) variables on mathematics homework outcomes should be null, consistent with the hypothesis that all the effects of social-cognitive constructs on behavior are mediated by intention. The only exception is perceived behavioral control which is hypothesized to predict mathematics homework outcomes directly (H_{15}) when perceived behavioral control serves as a proxy for actual control over behavior (Ajzen, 1991). Finally, we also hypothesized that there would be no direct effects of perceived autonomy support on intentions (H_{16}) and mathematics homework outcomes (H_{17}) on mathematics homework behavioral engagement because we expect the influence of this variable on these outcomes to be mediated by motivational and social-cognitive constructs in the model (see Figure 1 and Table 1).

There are also several important indirect effects in the trans-contextual model that provide detail on the processes by which the motivational factors in the educational context affect motivation, intention, and action in the out-of-school context (see Table 1). This network of relationships is referred to as a 'motivational sequence' (c.f., Vallerand, 1997). Consistent with previous research (McLachlan & Hagger, 2010b), perceived support for autonomy is not only likely to foster autonomous motivation in that context, but also autonomous motivation toward similar activities outside of school, such as mathematics homework, mediated by autonomous motives in the school context (H_{18}). Consistent with previous integrations of self-determination theory and the theory of planned behavior (Hagger & Chatzisarantis, 2009b; Hagger et al., 2006), autonomous motivation in the educational context is also expected to be related to intentions to engage in mathematics homework in the future mediated by autonomous motivation at home and the proximal predictors of intention from the theory of planned behavior, namely, attitudes (H_{19}) and perceived behavioral control (H_{20}). Autonomous motivation in the educational context is also proposed to affect mathematics homework outcomes mediated by autonomous motivation at home, intention, and attitudes (H_{21}) and perceived behavioral control (H_{22}). Similarly, autonomous motivation toward homework is expected to predict intentions mediated by the attitude (H_{23}) and perceived behavioral control (H_{24}) variables. Autonomous motivation at home is also expected to indirectly predict mathematics homework outcomes mediated by attitudes (H_{25}) and perceived behavioral control (H_{26}) and intentions. Finally, consistent with predictions from previous tests of the trans-contextual model (Hagger et al., 2005; Hagger et al., 2003)), perceived autonomy support is expected to have a significant indirect effect on mathematics homework behavioral engagement via the entire motivational sequence (H_{27}). This effect indicates the behavioral relevance of autonomy support in an educational context to actual engagement in homework behavioral outcomes outside of school[2].

1.2. The present study

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

[2]We 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.

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

2. Materials and methods

2.1. Participants

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

2.2. Research design

We employed a three-wave prospective correlational design consistent with previous studies adopting the trans-contextual model. Measures were adapted versions of those used in previous tests of the trans-contextual model. In the first-wave of data collection, self-report measures of students' perceived autonomy support for mathematics by teachers and autonomous and controlled forms of motivation for mathematics activities in a classroom context were administered. One week later, a second-wave questionnaire was administered including measures of theory of planned behavior components (Ajzen, 2003) and autonomous and controlled forms of motivation for mathematics homework (Ryan & Connell, 1989). After five weeks, self-reported homework engagement was measured. In addition, averaged grades for the formally-assessed homework assignments (N = 8 to 10) completed by the students over the five-week follow-up period were sourced from participants' mathematics teachers.

2.3. Measures

Participants completed questionnaires containing self-report measures of the psychological constructs of the trans-contextual model that had been previously-validated in tests of the model in other contexts. Measures were modified to make reference to the behaviors of interest: engaging in mathematics activities in the classroom or mathematics homework engagement. Measures included in the questionnaires were: perceived autonomy support for mathematics by teachers using an adapted version of the Perceived Autonomy Support Scale for Exercise Settings (PASSES; Hagger et al., 2007); autonomous (intrinsic and identified regulations) and controlled (external and introjected regulations) forms of motivation from self-determination theory based on Ryan and Connell's (1989) perceived locus of causality inventory in the school (mathematics lessons) and out-of-school (homework) contexts; and homework intentions, attitudes, subjective norms, and perceived behavioral control from the theory of planned behavior developed according to published guidelines (Ajzen, 2003). Mathematics homework outcomes, the target dependent variable, was assessed by self-reported homework engagement and students' aggregate grades attained for their homework assignments over the five-week period between the second and third waves of data collection. Self-reported homework engagement was based on measures of behavior used within the trans-contextual model in other contexts (Hagger et al., 2005; Hagger et al., 2003) and students' grades was an average grade across the eight and ten pieces of assessed homework that students had completed in the five-week period. Full details of measures used in the current study are provided in the measures table available as online supplemental material (Appendix A). We also included a self-report measure of past effort on mathematics homework at the second wave of data collection which was used as a control variable in the model to account for previous mathematics homework engagement consistent with previous research (Bagozzi & Warshaw, 1990).

2.4. Data analysis

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

Construct validity of the latent factors was established using the average variance extracted (AVE) and composite reliability coefficients (ρ) (Diamantopoulos & Sigauw, 2000). Discriminant validity is supported when the square-root of the AVE for each latent variable exceeds its correlation coefficient with other latent variables. Adequacy of the proposed model was established using multiple criteria for goodness of including the goodness-of-fit (GoF) index (Tenenhaus, Vinzi, Chatelin, & Lauro, 2005), average path coefficient (APC), average R^2 (ARS), and average variance inflation factor for model parameters (AVIF) statistics (Kock, 2013). Hypothesized mediation effects were tested by calculating indirect effects using a bootstrap resampling method with 100 replications (Kock, 2013).

3. Results

3.1. Participants

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

3.2. Preliminary analyses

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

[3]We 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.

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

3.3. Model effects

Standardized parameter estimates for the structural relations among the trans-contextual model factors in the proposed model are given in Figure 2. Perceived autonomy support had a statistically significant effect on autonomous motivation toward mathematics in school (H_1). There was a significant trans-contextual effect of autonomous motivation between the school and home contexts (H_2). Autonomous motivation in the home context predicted attitudes (H_3), but also positively predicted subjective norms, which was contrary to our predictions, so we rejected our hypothesis (H_5). There was no effect of autonomous motivation at home on perceived behavioral control leading to the rejection of the hypothesis (H_4). Contrary to predictions, there was a significant direct effect of autonomous motivation in the school context on attitudes toward mathematics homework, which led us to reject the hypothesis (H_6). There were no direct effects of autonomous motivation in school on perceived behavioral control (H_7) and subjective norms (H_8) as hypothesized. Attitudes (H_9) and subjective norms (H_{10}) exhibited significant effects on intention toward mathematics homework as predicted, but there was no effect for perceived behavioral control, which led us to reject the hypothesis (H_{11}). There was no direct effect of attitudes on mathematics homework outcomes (H_{13}). In contrast, we hypothesized a null direct effect of subjective norms but found a statistically significant effect leading to a rejection of this hypothesis (H_{14}). Perceived behavioral control had no direct effect on mathematics homework outcomes, so we rejected our hypothesis (H_{15}). The hypothesized effect of intention on mathematics homework outcomes was statistically significant (H_{12}). The direct effects of perceived autonomy support on intention (H_{16}) and mathematics homework outcomes (H_{17}) were not statistically significant consistent with our predictions.

We also predicted that the distal constructs in the model would have indirect effects on proximal psychological and mathematics homework outcome variables mediated by the proposed motivational sequence. As predicted, there were significant indirect effects of perceived autonomy support for mathematics in school on autonomous motivation in the home context mediated by autonomous motivation in the school context (H_{18}, $\beta = .151$, CI_{95} [.077, .225], $p < .001$). Autonomous motivation in the school context was also hypothesized to predict mathematics homework intentions and mathematics homework outcomes mediated by autonomous motivation at home and the attitude and perceived behavioral control constructs. Given that the effect of autonomous motivation at home on perceived behavioral control was not significant, there were no indirect effects on intentions (H_{20}) and mathematics homework outcomes (H_{22}) through this variable, leading to a rejection of our hypotheses. There were, however, significant indirect effects of autonomous motivation in school on intentions (H_{19}, $\beta = .138$, CI_{95} [.030, .246], $p < .001$) and mathematics homework outcomes (H_{21}, $\beta = .038$, CI_{95} [.024, .062], $p = .002$) through autonomous motivation at home and attitudes as predicted. The indirect effect of autonomous motivation at home on intention mediated by attitude was also significant (H_{23}, $\beta = .232$, CI_{95} [.130, .334], $p < .001$), although the indirect effect through PBC was not, so we rejected our hypothesis (H_{24}). Similarly, there were significant indirect effects of autonomous motivation at home on mathematics homework outcomes mediated by attitudes and intention (H_{25}, $\beta = .087$, CI_{95} [.040, .134], $p < .001$). There was no indirect effect of out-of-school autonomous motivation on mathematics homework outcomes mediated by perceived behavioral control and intention, contrary to hypotheses (H_{26}). There was also no effect of out-of-school autonomous motivation on mathematics homework outcomes mediated by subjective norms and intention, the significant effects of autonomous motivation on subjective norms and subjective norms on intention notwithstanding. Finally, consistent with hypotheses, we found a significant overall indirect effect of perceived autonomy support on mathematics homework outcomes mediated by the motivational sequence involving autonomous motivation in both contexts, the proximal antecedents of intention, and intention (H_{27}, $\beta = .042$, CI_{95} [.009, .075], $p = .021$).

4. Discussion

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

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

We also found a statistically significant and positive effect of the autonomous forms of motivation on subjective norms. We hypothesized a negative relation because subjective norms reflects beliefs regarding social pressure to act and are, therefore, consistent with controlled motivation and inconsistent with autonomous motivation. A possible reason for the positive effect is that normative beliefs with respect to homework represent students' internalized beliefs regarding salient others' expectations (e.g., teachers, parents). According to self-determination theory, internalization is the process by which individuals view the demands and instructions of salient others as important to their goals instead of controlling (Ryan, 1995). Internalization, therefore, reflects individuals' choice to adhere to the commands of significant others and, therefore, *autonomously* decide to conform (Deci, Eghrari, Patrick, & Leone, 1994; Ryan & Connell, 1989). Students in the current study, therefore, may have internalized salient others' demands to complete their homework and viewed the demands as supportive of their autonomous motivation. This finding could represent a modification or caveat to the trans-contextual model and future research may seek to distinguish between autonomous and controlled normative beliefs similar to the same distinction made by Chatzisarantis et al. (1997; 2007; 2006) for intentions. Finally, subjective norms were also a significant positive direct predictor of mathematics homework outcomes. This is contrary to the hypotheses of the trans-contextual model and the theory of planned behavior. To speculate, this path may be explained by unmeasured norm-related mediators which account for the motivational effects of subjective norms of behavior more effectively than intentions. It may also reflect more spontaneous, automatic participation in the behavior due to the influence of significant others mitigating the need to deliberate over acting (Hagger et al., 2006; Trafimow & Finlay, 1996).

Overall, our findings provide preliminary evidence that school students that report autonomous motivation among toward the activities they perform in their mathematics lessons are more likely to be autonomous motivated toward their mathematics homework they do in out-of-school contexts, are more likely to hold beliefs and intentions consistent with those motives toward future engagement in mathematics homework, and are more likely to report having engaged in mathematics homework outcomes. This means that mathematics teachers who are able to support students' autonomous motivation in class are also likely to foster autonomous motivation outside of school. One way to do this is to promote in autonomy-supportive behaviors among mathematics teachers in their lessons (Reeve & Jang, 2006). The link between perceived autonomy support and autonomous motivation toward mathematics activities in the educational context in the current research indicates the potential effectiveness that autonomy supportive behaviors could have on students' motivation. This is important because one of the key goals of education is to foster self-directed learning in students, which means they are more likely to persist with self-directed learning activities (e.g., homework) in the absence of extrinsic reinforcing agents (Deci et al., 1991; Reeve, 2002). The trans-contextual model may therefore provide the basis for interventions that promote transfer of motivation from educational to out-of-school contexts (Chatzisarantis & Hagger, 2009; Yli-Piipari, Layne, & Irwin, 2014).

5. Conclusions

Current findings provide preliminary evidence that students' perceptions of what their teachers say and do in mathematics classes affect their motivation toward learning activities in class and their motivation toward learning outside of school. Strengths of the current research include the adoption of an appropriate multi-theory approach and its application in a unique context, and the use of a prospective three-wave design, validated measures, and appropriate measures of students' mathematics homework engagement and attainment. The study is not without limitations and we briefly outline a few here. First, our prospective design limits the extent to which we can infer causality (Hagger & Chatzisarantis, 2009a). Future research should seek to engage in experimental tests that may further elucidate the causal relations inferred in the model (Bagozzi, 2010). Second, we did not account for all sources of autonomy support in our model and future studies should also evaluate the importance of parental support for autonomy toward mathematics homework outcomes (Hagger et al., 2009). Related to this, it might be interesting to measure and control for the effects of teachers' other education-related behaviors beyond the autonomy-support techniques specified in the trans-contextual model. Third, we did not include measures of basic psychological need satisfaction in our current study. Need satisfaction may be a determinant autonomous motivation in educational contexts and out-of-school contexts (Barkoukis et al., 2010), but may also serve to mediate effects of perceived autonomy support on autonomous motivation. We look to future studies to test this mediation hypothesis in mathematics education. Fourth, there is a need to replicate current findings to further confirm the generalizability of model predictions, consistent with recent work replicating the model in multiple academic contexts (e.g., Chan et al., 2015; Hagger, Sultan, Hardcastle, & Chatzisarantis, 2015) and behavioral contexts (e.g., Chan & Hagger, 2012). Fifth, testing proposed model effects on other education-related outcomes, and the role that other moderating and mediating variables might play in the model, would be fruitful avenues for future research.

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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 (+)

Note. s = school or educational context; h = home or out-of-school context; PBC = perceived behavioral control. [a]Denotes 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
Tenenhaus 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.

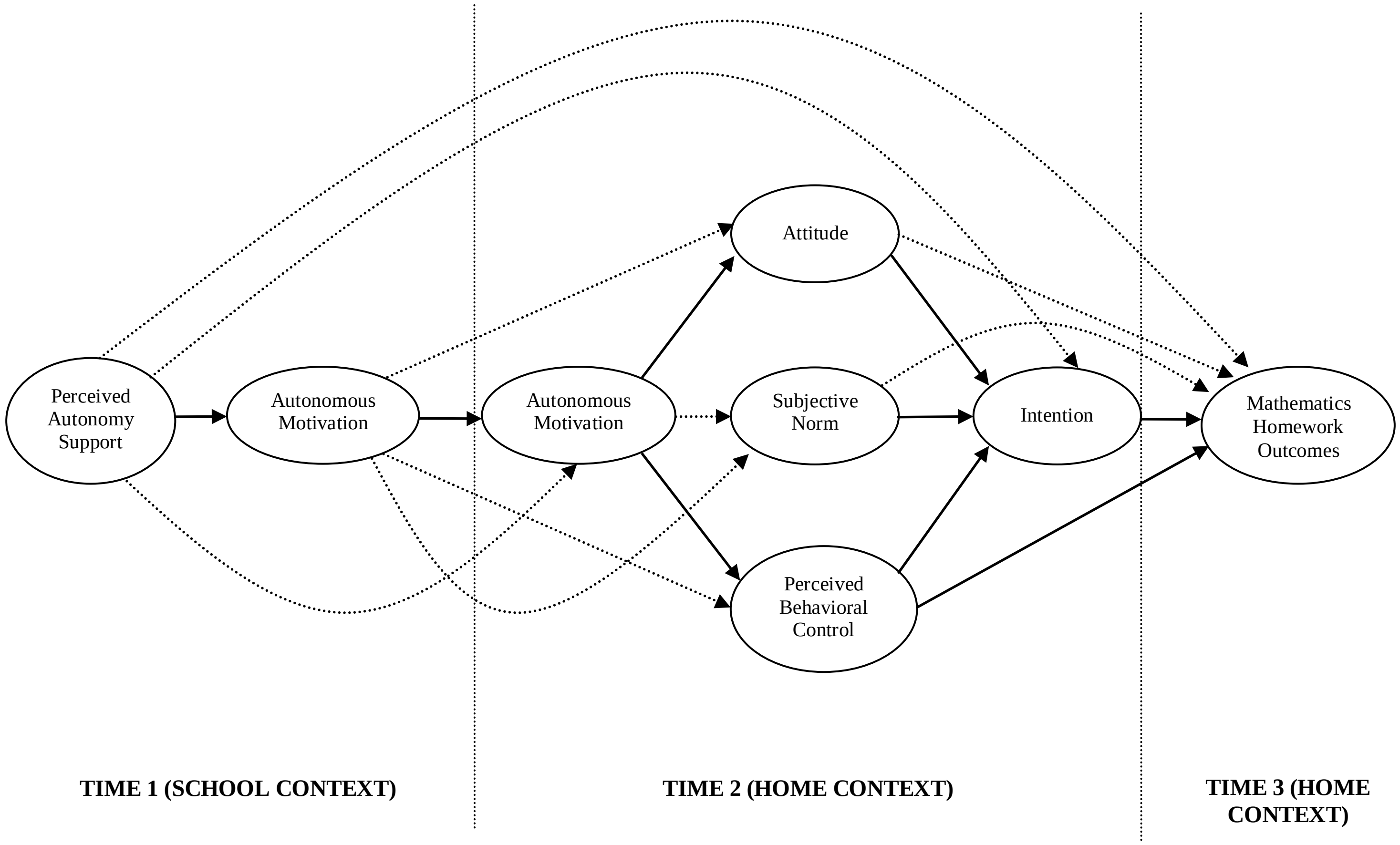
Note.

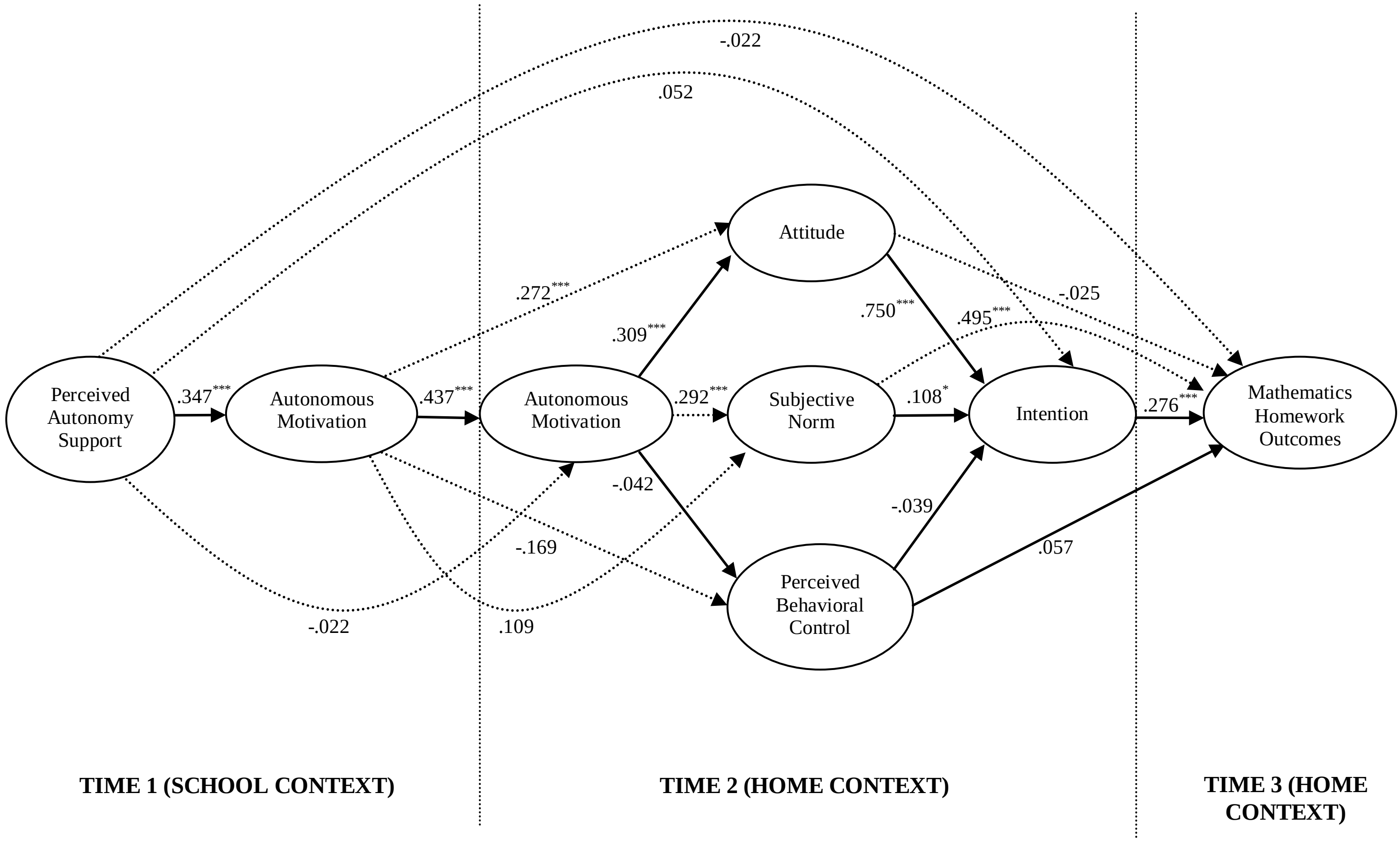
Broken lines between constructs indicate direct effects proposed to be non-significant or unsubstantial relative to the indirect effects.

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, $\beta = .377$, $p < .001$.


Perceived Autonomy Support
Autonomous Motivation
Autonomous Motivation
Attitude
Subjective Norm
Perceived Behavioral Control
Intention
Mathematics Homework Outcomes
TIME 1 (SCHOOL CONTEXT)
TIME 2 (HOME CONTEXT)
TIME 3 (HOME CONTEXT)


-.022
.052
Attitude
.272***
.309***
.750***
.495***
-.025
Perceived Autonomy Support
.347***
Autonomous Motivation
.437***
Autonomous Motivation
.292***
Subjective Norm
.108*
Intention
.276***
Mathematics Homework Outcomes
-.042
-.039
-.169
.057
Perceived Behavioral Control
-.022
.109
TIME 1 (SCHOOL CONTEXT)
TIME 2 (HOME CONTEXT)
TIME 3 (HOME CONTEXT)

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 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	1 = Strongly agree, 7 = Strongly disagree
Perceived locus of causality (school)	Intrinsic motivation	Stem: I do maths exercises and solve maths problems in my maths lessons because… …maths exercises and problems are enjoyable …I enjoy learning new skills … maths is fun	1 = Not true at all, 4 = Very true
	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… …maths exercises and problems are enjoyable …I enjoy doing maths homework …doing maths homework is an important part of my life	1 = Not true at all, 4 = Very true
	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 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	1 = Unlikely, 7 = Very likely

	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 sematic 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 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	1 = strongly agree, 7 = strongly disagree
Perceived locus of causality (school)	Intrinsic motivation	Stem: I do maths exercises and solve maths problems in my maths lessons because… …maths exercises and problems are enjoyable …I enjoy learning new skills … maths is fun	1 = “not true at all”, 4 = “very true”
	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… …maths exercises and problems are enjoyable …I enjoy doing maths homework …doing maths homework is an important part of my life	1 = “not true at all”, 4 = “very true”
	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 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	1 = Unlikely, 7 = Very likely
Theory of planned behavior	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 sematic 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
Maths 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
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