

Perceived Autonomy Support and Autonomous Motivation toward Mathematics Activities in Educational and Out-of-School Contexts is Related to Mathematics Homework Behavior and Attainment

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Abstract

We adopted a trans-contextual model of motivation to examine the processes by which school students' perceived autonomy support (defined as students' perceptions that their teachers' support their autonomous or *self-determined* motivation) and autonomous forms of motivation (defined as motivation to act out of a sense of choice, ownership, and personal agency) toward mathematics activities in an educational context predict autonomous motivation and intentions toward mathematics homework, and actual mathematics homework behavior and attainment, as measured by homework grades, in an out-of-school context. A three-wave prospective study design was adopted. High-school students ($N = 216$) completed self-report measures of perceived autonomy support and autonomous forms of motivation toward mathematics activities in school in the first wave of data collection. One-week later, participants completed measures of autonomous forms of motivation, attitudes, subjective norms, perceived behavioral control, and intentions with respect to mathematics homework outside school. Students' self-reported homework behavior and homework grades from students' class teachers were collected five-weeks later. A structural equation model supported model hypotheses. Perceived autonomy support and autonomous forms of motivation toward mathematics activities in school were related to autonomous forms of motivation toward mathematics homework outside of school. Autonomous forms of motivation toward mathematics homework predicted intentions to do mathematics homework mediated by attitudes, subjective norms and perceived behavioral control. Intentions predicted self-reported mathematics homework behavior and mathematics homework grades. Perceived autonomy support and autonomous forms of motivation toward mathematics in school had statistically significant indirect effects on mathematics homework intentions mediated by the motivational sequence of the model. Results provide preliminary support for the model and evidence that autonomous motivation toward mathematics activities in the classroom is linked with autonomous motivation, intention, behavior and actual attainment in mathematics homework outside of school.

Key words: self-determination theory; theory of planned behavior; motivational transfer; theoretical integration; intention; mathematics education

1. Introduction

1.1. Homework and educational outcomes

An important question for any school educator is whether his or her instruction will affect students outside the school environment. Setting homework is a key means by which educators can evaluate whether in-class learning is adopted and applied by students beyond the classroom. Homework, therefore, is an important activity to promote further development of skills learned in school. Research has consistently demonstrated that school students who do homework have consistently higher academic attainment compared to those who do not (Cooper, Robinson, & Patall, 2006; Trautwein, 2007; Trautwein, Köller, Schmitz, & Baumert, 2002). Despite strong support for the relation between homework and academic attainment, there is evidence that students do not always complete their assignments or fail to invest sufficient effort in completing them. Research demonstrates that a substantial proportion of school students fail to adequately complete set homework, which could potentially limit learning and adversely affect long-term academic attainment (Markow, Kim, & Liebman, 2007). There is also evidence that the degree of effort that students invest in completing their homework assignments is related to more effective learning and better grades (Trautwein, 2007; Trautwein, Ludtke, Kastens, & Koller, 2006). Educators and teachers are, therefore, interested in identifying the motivational factors associated with school students' completion of, and effort invested in, homework assignments. Of particular interest are the antecedents of *self-regulation* of homework behavior, such that students complete set homework independently with minimal external prompting or reinforcement.

A key factor related to the self-regulation of behavior in educational contexts is self-determined or *autonomous* motivation. Autonomous motivation reflects doing tasks and behaviors out of a sense of choice, ownership, and personal agency. Research has indicated that autonomously-motivated children acting in school contexts are more likely to pay attention and invest more effort in class and demonstrate adaptive educational outcomes such as better

overall grades (Deci, Ryan, & Williams, 1996; Deci, Vallerand, Pelletier, & Ryan, 1991; Ntoumanis, 2005; Pintrich & Degroot, 1990; Wong, Wiest, & Cusick, 2002). The mechanism by which autonomous motivation leads to adaptive educational outcomes is through greater interest, effort and application toward instruction, and, particularly, greater involvement in self-directed study outside of the class (Reeve, 2002; Skinner & Belmont, 1993). Means to promote greater autonomous motivation has traditionally been through autonomy-supportive techniques and behaviors demonstrated by teachers in the classroom (Reeve, Bolt, & Cai, 1999; Reeve & Jang, 2006; Su & Reeve, 2011). Research has shown that teachers that provide choice, acknowledge conflicts, allow students to adopt an exploratory or questioning approach, provide encouragement and positive, task-related feedback, and avoid using controlling, didactic language foster greater autonomous motivation in their students compared to those who do not (Reeve et al., 1999; Reeve & Jang, 2006). A mathematics teacher may, for example, structure his or her lessons accordingly to promote autonomy by providing a clear rationale for solving particular problems or equations (e.g., showing how they might apply to real-world contexts), allow students to investigate those applications in pairs or groups, providing hints, but not answers, as the students continue, and accompanying progress and success with positive feedback.

A key assumption of self-determination theory applied to educational contexts is that if teachers and instructors adopt autonomy-supportive techniques and behaviors in their lessons, students' will perceive their teachers to be supportive of their autonomy. Students who perceive their teachers to be autonomy-supportive are more likely to report autonomous motivation and adaptive educational outcomes (Jang, Kim, & Reeve, 2012). Although one of the assumed pathways by which the promotion of autonomous motivation in the classroom leads to distal adaptive educational outcomes (e.g., better grades) is through greater self-directed learning outside of the classroom (e.g., increased motivation toward, and effort invested in, completing homework assignments), there is relatively little research testing this

pathway relative to research examining in-class autonomous motivation and participation in educational activities (Hagger & Chatzisarantis, 2012; Vallerand, 1991; M. T. Wang, 2012).

Recently, researchers have begun to examine the process by which autonomous motivation in the classroom leads to autonomous motivation toward educational activities outside of formal educational contexts. Adopting a trans-contextual model motivation, an integrated theoretical model adopting hypotheses from theories of autonomous motivation and social cognition, Hagger et al. (2005; 2003; 2009) demonstrated that autonomous motivation toward activities in an educational context was strongly associated with autonomous motivation toward related activities outside of the school context. Furthermore, students' perceptions that their teacher supported their autonomy were also associated with autonomous motivation in the extra-mural context, mediated by autonomous motivation in the educational context. To date, research adopting the trans-contextual model has tested motivational transfer in physical education and leisure-time physical activity contexts (Hagger & Chatzisarantis, 2012). The model has not been applied to the promotion of self-directed learning activities in other academic subjects outside of school, such as doing mathematics homework, but has considerable potential to guide research on the transfer of motivation across classroom and out-of-school contexts.

The purpose of the current research was to adopt the trans-contextual model to examine the effects of school students' perceived autonomy support and autonomous motivation toward mathematics activities in the classroom on their autonomous motivation toward mathematics homework outside of school, a key self-directed learning activity. The research will make a unique contribution to understanding the extent to which motivation toward learning activities in educational contexts is related to motivation toward similar activities (e.g., homework) in an out-of-school context. It will also demonstrate how the motivational transfer across contexts is related to important education-related outcomes such as doing homework and actual homework attainment. We expect results to have important implications for educational practice by

demonstrating how the fostering of autonomous motivation in class may affect students' behavior toward learning activities outside of school.

1.2. Why focus on mathematics?

Our focus on mathematics education is in response to governmental and economic organisations' call to address the mathematical skills 'gap' in the workforce and their advocacy of high-quality education in multiple science, technology, engineering, and mathematics (STEM) subjects as a driver of economic growth (Hanushek & Woessmann, 2007; House of Lords, 2012). STEM subjects have been recognized as those in which there is a significant shortfall in expertise and where there is a substantial need for a highly-educated workforce. Promoting better skills, learning, and attainment in mathematics is important given the prominent role of mathematics competency in STEM subjects (X. L. Wang, 2013). Given evidence that students with low mathematics attainment during the early secondary school years are less likely to move on to study and gain employment in STEM-related subjects and professions (Anlezark, Lim, Semo, & Nguyen, 2008; Boe, Henriksen, Lyons, & Schreiner, 2011; Krogh & Andersen, 2013), identifying the motivational factors related to adaptive outcomes in in-class and out-of-school learning activities in mathematics may help inform interventions to improve mathematics competency (Steinmayr, Dinger, & Spinath, 2012).

1.3. The Trans-Contextual Model

The trans-contextual model is an integrated theoretical model that outlines the process by which students' perceptions of their teachers' support for autonomous motivation in educational contexts relates to autonomous motivation for learning activities in class (e.g., solving mathematics problems) and, importantly, autonomous motivation toward related learning activities in out-of-school contexts (e.g., doing homework). The model also provides an indication of the links between autonomous motivation and future participation in educational activities in out-of-school contexts (Hagger et al. 2003, 2005, 2009). Model hypotheses are based on three prominent theories that have been applied to understand

intentional, motivated behavior in numerous contexts: self-determination theory (Deci & Ryan, 1985), Vallerand's (1997) hierarchical model of intrinsic and extrinsic motivation, and the theory of planned behavior (Ajzen, 1991).

The basic propositions of the model are illustrated in Figure 1. The first key effect in the model is the relation between students' perceptions of their teachers support for autonomy and students' autonomous forms of motivation (path 1, Figure 1). School students who view their teachers as autonomy supportive are more likely to participate in class learning activities for autonomous reasons (Guay et al., 2001). Students operating in class environments that are autonomy supportive are more likely to experience a sense of choice over their actions, and experience interest and enjoyment in class learning activities (Lepper, Corpus, & Iyengar, 2005; Patall, Cooper, & Wynn, 2010; Reeve & Jang, 2006). They are also more likely to invest effort and persist with those activities in the absence of external prompting or reinforcement. The model also proposes that experiencing autonomous motivation toward activities in class will lead students to participate in, and persist with, activities in similar contexts from which they are likely to derive like experiences of interest, competence, and enjoyment. In the current research, we expect school students experiencing the activities they do in their lessons as autonomous will be more likely to be autonomously motivated toward their homework assignments in an out-of-school context (path 2, Figure 1). The mechanism underpinning this link is derived from Vallerand's (1997) hierarchical model of intrinsic and extrinsic motivation. The experience of a behavior or action as autonomous in a given context (e.g., solving mathematics problems in class) creates a script or schema containing the motivational representations and anticipated patterns of action in that context. The schema may subsequently serve as a useful template for motivation and action in closely-related contexts (e.g., completing mathematics homework assignments outside of school) particularly when similar cues are identified and activate the schema.

The model also specifies that students who are autonomously motivated in out-of-school contexts will be more likely to intend to participate in out-of-school learning activities they find to be autonomously motivating (e.g., mathematics homework). Hypotheses from the theory of planned behavior, a social cognitive model that outlines the immediate antecedents of intentional behavior, are incorporated into the model to account for this process (Ajzen, 1991). It is predicted that students will align their beliefs toward their future participation in such activities with their motives (path 3, Figure 1). The beliefs include attitudes, which reflect the individual's belief that the behavior will lead to desired outcomes, subjective norms, representing the social pressure salient social agents place on individuals to act, and perceived behavioral control, reflecting the individual's beliefs in personal capacity to do the behavior. Autonomously-motivated students will be more likely to hold positive attitudes and perceptions of behavioral control toward homework activities because they view it as an opportunity to experience the adaptive outcomes such as interest, competence and enjoyment linked to the activity (Deci & Ryan, 1985; Hagger & Chatzisarantis, 2009). Consistent with the theory of planned behavior, the beliefs will be related to intentions to do, and actual participation in, future homework assignments, homework grades, and overall academic grades (paths 4, Figure 1). The model therefore charts a motivational sequence in which perceived support for autonomy from teachers is related to autonomous motivation toward educational activities in school and also toward doing homework in out-of-school contexts.

The proposed effects in the model have been independently supported in numerous studies from multiple research groups (e.g., Hagger et al., 2005; Hagger et al., 2003; Shen, McCaughy, & Martin, 2008; Standage, Gillison, Ntoumanis, & Treasure, 2012). The studies typically adopt a three-wave prospective survey design in which psychometric measures of the model constructs in the educational context are measured in an initial wave of data collection, followed by construct from the out-of-school context one-week later to allay common method variance. Measures of behavior are taken at a final wave of data collection, often some weeks

later. The majority of tests of the model have been confined to the physical education and extra-mural physical activity participation contexts. The model processes, however, have been proposed to generalize to multiple educational and out-of-school contexts, including motivation toward academic subjects (Hagger & Chatzisarantis, 2012). In the present study, we aimed to adopt the model as a basis to predict the transfer of students' motivation toward mathematics activities across school and out-of-school contexts.

1.4. The present study

1.4.1. Study overview and aims

The purpose of the present study is to adopt the trans-contextual model to explain the processes by which motivational factors toward mathematics activities in a school context relate to motivation, intentions, behavior, and attainment with respect to mathematics homework in an out-of-school context. The application of the model to understand mathematics homework is important given evidence that students are turning away from traditional mathematics- and science-based disciplines in their educational choices in favor of alternative subjects (Hodgen, Kuchemann, Brown, & Coe, 2009). This research is also important as it will provide the first evidence that the trans-contextual model can be applied to an academic discipline like mathematics homework, which may also provide a basis for its use in other academic domains.

A further innovation of the current study is to introduce an objective outcome measure, namely, mathematics homework grades, alongside self-reports of mathematics homework behavior. Previous research has typically relied on self-reports of behavior, which is likely to inflate error variance (Hagger & Chatzisarantis, 2012). Given that homework grades are dependent on a student's motivation, effort, and persistence it will serve as an accurate indicator of the quality of students' homework behavior, a key outcome of the present study.

1.4.2. Hypotheses

Our proposed study will adopt the three-wave prospective design pioneered in previous research using the trans-contextual model and will test sets of hypotheses related to paths 1-5 illustrated in Figure 1. Specific hypotheses are summarized in Table 1 and the proposed path model is illustrated in Figure 2. The first set of hypotheses (path 1, Figure 1) relates to the effects of school students' perceptions that their class teacher supports forms of motivation from self-determination theory in a classroom context. Specifically, perceived autonomy support provided by their teachers for educational activities in the classroom is hypothesized to be related to their autonomous forms of motivation, namely, intrinsic motivation (H_{1a}) and identified regulation (H_{1b}). The hypothesized link between perceived autonomy support and autonomous motivation is consistent with the proposal in self-determination theory that environmental contingencies that foster a sense of choice, personal involvement, and agency are likely to engender self-determined motivational orientations (Deci & Ryan, 1985; Deci et al., 1991). Students that recognise teachers and instructors as autonomy-supportive will therefore be more likely to experience classroom activities as autonomously motivating (Pelletier, Fortier, Vallerand, & Briere, 2001). A further proposition of the trans-contextual model is that the experience of autonomous motivation toward learning activities in lessons, such as solving mathematics problems, is likely to engender autonomous motivation toward similar learning activities in out-of-school contexts, such as doing mathematics homework (path 2, Figure 1). As a consequence, autonomous forms of motivation (intrinsic motivation, H_{2a} ; identified regulation, H_{2b}) in the educational context are proposed to be related to corresponding autonomous forms of motivation in the out-of-school context. The trans-contextual link, a fundamental pathway in the model, is consistent with Vallerand's (1997) proposal that experiencing autonomous motivation in one context will develop a motivational schema that may promote autonomous motivation toward similar activities in other contexts. We also hypothesize that perceived autonomy support will predict autonomous motivation to do homework outside-of-school mediated by autonomous forms of motivation (intrinsic

motivation, H_{2c} ; identified regulation, H_{2d}) in educational contexts. This pathway reflects the proposition that perceived support for autonomy in one context is also likely to engender autonomous motivation in another due to the individual experiencing activities in the original context as autonomous (Hagger et al., 2003).

Another key proposition of the trans-contextual model is that autonomous forms of motivation toward homework in the out-of-school context will be related to the belief-based social-cognitive variables that underpin intentional behavior (path 3, Figure 1). These relations reflect the original proposal in self-determination theory that individuals who perceive activities and behaviors as autonomously motivated will seek out such behaviors in future and, in order to do so, will align their systems of beliefs and intentions to participate in those activities and behaviors so that they are consistent with their motives (Deci & Ryan, 1985). Specifically, it is proposed that forms of autonomous motivation will be related to attitudes (intrinsic motivation, H_{3a} ; identified regulation, H_{3b}) and perceived behavioral control (intrinsic motivation, H_{3c} ; identified regulation, H_{3d}). In contrast, we expect no relation between this variable and autonomous forms of motivation (intrinsic motivation, H_{3e} , and identified regulation, H_{3f}). As the subjective norms construct reflects the perceived effects of social agents' desires regarding the behavior and is generally interpreted as pressuring and controlling, it is less likely to be aligned with autonomous forms of motivation and more likely to be aligned with more controlling motives (Hagger & Chatzisarantis, 2009; McLachlan & Hagger, 2011).

Consistent with hypotheses of the theory of planned behavior (path 4, Figure 1), intentions are expected to be a function of attitudes (H_{4a}), subjective norms (H_{4b}), and perceived behavioral control (H_{4c}). The pathway reflects the proximal belief-based antecedents of intention consistent with previous theory and research (Armitage & Conner, 2001; Hagger, Chatzisarantis, & Biddle, 2002; McEachan, Conner, Taylor, & Lawton, 2012). Autonomous forms of motivation in the out-of-school context are also proposed to be related to intentions to

do mathematics homework in the future mediated by the proximal predictors of intention from the theory of planned behavior, namely, attitudes (intrinsic motivation, H_{4d}; identified regulation, H_{4e}) and perceived behavioral control (intrinsic motivation, H_{4f}; identified regulation, H_{4g}). We included a direct effect of perceived autonomy support on intentions (H_{4h}), but we hypothesize no effect as the relation is proposed to be mediated by the motivational sequence involving the motivational and social-cognitive constructs. This is consistent with the original proposal of the trans-contextual model (Hagger et al., 2003) and the proposal of similar integrated models (Guay, Mageau, & Vallerand, 2003; Hagger & Chatzisarantis, 2009; Sarrazin, Vallerand, Guillet, Pelletier, & Cury, 2002) where distal variables affect intentions by influencing their motivational and decision-making antecedents. In the current model, we are not only interested in how students' perceptions that salient others (e.g., teachers) support their autonomy in an educational context (e.g., participating in activities in mathematics lessons) affect motivation that context, but also how they affect motivation in another (e.g., doing mathematics homework outside of school). We also want to demonstrate that perceptions of autonomy support have relevance for future participation in education-related behaviors outside of school. We therefore hypothesize that the indirect effect for this variable on intentions, the immediate precursor of behavior, occurs through the motivational sequence involving motivational constructs in both contexts (Hagger & Chatzisarantis, 2009). The inclusion of the direct effect was to test whether the proposed sequence completely mediated the link between perceived autonomy support and intentions or whether an unmediated residual direct effect remained (Hagger, Chatzisarantis, & Harris, 2006a).

Intentions are proposed to be the only direct predictor of behavioral outcomes (path 5, Figure 1), mathematics homework behavior (H_{5a}) and grades (H_{5b}). We proposed no direct effects of the attitude and subjective norm variables on actual behavior, consistent with the theory that all the effects of social-cognitive constructs on behavior are mediated by intention (Ajzen, 1991). The only exception to this is perceived behavioral control which was

hypothesized to predict mathematics homework behavior (H_{5c}) and grades (H_{5d}) directly. This is to account for occasions where the perceived behavioral control captures actual, rather than perceived, behavioral constraints (Ajzen, 1991). Autonomous forms of motivation toward homework are also expected to be related to mathematics behavioral outcomes, namely, mathematics homework behavior and grades, mediated by intention, attitudes and perceived behavioral control (H_{5e} - H_{5i}). 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 statistically significant indirect effects on the behavioral outcomes via the entire motivational sequence (H_{5m} , H_{5n}), illustrating the increased likelihood that autonomy support in the classroom is transferred to actual behavioral outcomes outside of school. Overall, the proposed indirect effects provide an illustration of the process by which perceived autonomy support and autonomous motivation toward mathematics activities in a school context leads to autonomous motivation, intentions, and actual homework behavior and attainment in mathematics homework outside of school.

2. Method

2.1. Participants

We recruited school students ($N = 220$) aged 12 to 15 years from three co-educational state high schools in the city of Multan, Pakistan to participate in the study. We secured ethical clearance for the study protocol from the Multan district Ministry of Education and from the Institutional Review Boards of the participating Universities prior to data collection. School principals were the primary contact and granted consent for the researchers to collect data in the schools. We followed-up the initial contact with the principals with direct contact with mathematics class teachers who provided access to mathematics lessons for the research team to recruit and collect data from eligible students. We obtained participants' parental consent prior to data collection via a letter sent home with eligible students giving details of the study prior to data collection. A pre-printed form was provided for parents to sign and return to the

students' home-room teacher if they wanted to opt their child out of participation in the study. No forms were returned. We obtained participants' demographic information from records held by the school registry including whether their domicile was urban or rural, their socioeconomic background according to their main caregiver's occupation, and their first-spoken language.

2.2. Research design

Consistent with previous studies adopting the trans-contextual model, we employed a three-wave prospective correlational design. We adapted versions of measures used in previous tests of the trans-contextual model and its component theories. In the first-wave of data collection, we administered self-report measures of perceived autonomy support for mathematics by teachers and the perceived locus of causality toward mathematics in a classroom context. One week later, we administered a second-wave questionnaire including measures of the components of the theory of planned behavior (Ajzen, 1985) and perceived locus of causality toward mathematics exercises at home (Mullan, Markland, & Ingledew, 1997). The one-week latency period was used to allay the common method variance associated with the use of similar methods to measure the self-determination theory constructs. After five weeks, we measured self-reported homework behavior. In addition, we sourced averaged grades for the homework assignments completed by the students over the five-week follow-up period from participants' mathematics teachers.

Researchers collected questionnaire data during regular mathematics lessons under quiet classroom conditions. We told participants that they would be asked to complete a series of brief surveys as part of a survey on young people's attitudes toward mathematics. We also informed them that their participation was entirely voluntary and they could choose not to complete the questionnaire. They were informed that if they opted not to participate they could either sit quietly, read their class textbooks, or complete assignments while the others completed the questionnaire. None of the students chose to opt out of completing the questionnaire. Participants were separated so that they could not confer. We told participants'

not to include their name on the questionnaire in order to preserve anonymity for ethical reasons. In order to minimize demand characteristics, we also informed participants that the research team was interested in their opinions only, there were no ‘right’ or ‘wrong’ answers to the questionnaire items, only the researchers would handle the questionnaires and see the responses, and they were free to answer honestly and be as candid as they wanted. Measures across time points were matched via a unique participant code comprising birth date and gender.

2.3. Measures

2.3.1. Perceived autonomy support for mathematics by teachers

We measured school students’ 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). We modified the scale items so that they made reference to the mathematics context. Respondents were required to rate the extent to which their teacher supported their autonomy toward mathematics activities and learning in the classroom. The scale comprised twelve items (e.g. “I feel that my math teacher makes sure I really understand the goals of the lesson and what I need to do”) with responses made on seven-point scales ranging from “strongly disagree” (1) to “strongly agree” (7).

2.3.2. Perceived locus of causality in mathematics and out-of-school contexts

We adapted Ryan and Connell’s (1989) measure of perceived locus of causality in educational contexts to measure forms of autonomous forms of motivation in mathematics lessons. Participants were presented with initial instructions: “In this part of the survey you will be asked questions about why you do math exercises and problems in class. There are no right or wrong answers so please answer the questions honestly. Tick the box that best describes your opinion”. They were next presented with a common stem: “I do math exercises and solve math problems in my math lessons...” followed by six reasons, three for each of the autonomous forms of motivation: identified regulation (e.g., “...because it is important to me”)

and intrinsic motivation (e.g., "...because math is fun"). Responses were measured on four-point scales ranging from "not true at all" (1) to "very true" (4).

We developed a similar measure of autonomous motivation toward doing mathematics homework outside of the school based on Ryan and Connell's measure. An initial introductory paragraph was presented: "This questionnaire is about the homework assignments you are given by your teacher in math lessons for you to do outside of school (e.g., solving exercises, problems, and equations). Math homework does not include the activities you do during school time in your math classes. There are no right or wrong answers so please answer the questionnaire as honestly as you can. All you have to do is tick the box or circle the number which best describes your opinion." Participants were then presented with a common stem: "I do math homework because..." followed by three reasons for the two autonomous forms of motivation identified regulation (e.g., "...I think it is important to make the effort to do my math homework") and intrinsic motivation (e.g., "...it is fun"). Responses were made on seven-point scales ranging from "not true at all" (1) and "very true" (7)¹.

2.3.3. *The theory of planned behavior*

We developed items according to published guidelines (Ajzen, 2003) to tap constructs from the theory of planned behavior as part of the trans-contextual model. The items were specifically designed to correspond with the target behavior of mathematics homework set by the teachers over the specified time period of five weeks (target, action, context, and time). Three items measured intentions to do mathematics homework in future (e.g., "I plan to do my math homework set by my teacher at home over the next 5 weeks") on seven-point scales

¹We also included measures of two controlled forms of motivation from self-determination theory: external regulation (e.g., "...so that my teacher won't yell at me") and introjected regulation (e.g., "...because I would feel bad about myself if I didn't"). We opted not to include these measures for the following reasons: (i) the trans-contextual model focuses on the transfer of autonomous forms of motivation as these forms of motivation are considered the most adaptive, behaviorally, so it was deemed appropriate to prioritize that focus; (ii) the adoption of a graded single-variable measure of autonomous motivation based on a weighted composite of autonomous and controlled forms of motivation used in many studies including recent tests of the trans-contextual model has been criticized (Chemolli & Gagné, 2014); and (iii) the composite reliability coefficients for the introjected regulation scales in the classroom and out-of-school contexts and the external regulation scales in the classroom context did not exceed the 0.70 criterion, so it was considered inappropriate to include data on variables in the model for which the results could not be trusted due to low reliability.

anchored by “strongly disagree” (1) to “strongly agree” (7). Attitudes were assessed in response to the following question: “Doing the math homework set my teacher at home over the next 5 weeks is...” Responses were measured on five seven-point semantic differential scales with the following bipolar adjectives: *unenjoyable-enjoyable*, *bad-good*, *useless-useful*, *boring-interesting*, and *harmful-beneficial*. Subjective norms were measured by three items (e.g. “Most people who are important to me think that I should do my math homework over the next 5 weeks”) on seven-point scales with “strongly disagree” (1) to “strongly agree” (7) as endpoints. Perceived behavioral control was assessed by three items (e.g. “How much control do you have over doing your math homework over the next 5 weeks”) on seven-point scales ranging from (1) “no control” to (7) “complete control”.

2.3.4. *Self-reported mathematics homework behavior*

We assessed students’ mathematics homework behavior at the third wave of data collection based on previous self-reported measures of behavior (e.g., Hagger et al., 2003). Participants were asked to report how frequently they completed their mathematics homework (“Over the last five weeks how often have you done your math homework” and “How frequently did you do your math homework in the last five weeks”) with responses recorded on two seven-point scales with (1) “not at all” to (7) “all of the time” anchors.

2.3.5. *Mathematics homework attainment*

We measured students’ homework attainment from their mathematics homework grades over the duration of the study. The research team collected participants’ homework grades for the five-week follow-up period between the second and third waves of data collection from the school mathematics teachers. The students had completed seven assessed mathematics homework assignments in that period and we collected their average grades and converted them to an overall percentage.

2.3.6. *Past effort on mathematics homework*

In accordance with previous studies (e.g., Hagger et al., 2003), we also included a brief self-report measure of past effort on mathematics homework at the second wave of data collection. The measure was similar to the items used to measure self-reported homework behavior in the third-wave of data collection, with the exception that the time frame focused on the previous five-weeks. We asked participants to rate how much effort they had put into completing their mathematics homework in the previous five weeks (“How much did you try to do your math homework during the last 5 weeks?”) on a single item with responses made on seven-point scales with (1) “didn’t try at all” to (7) “tried very hard” endpoints. We used this measure as a control variable in our model to account for previous mathematics homework behavior consistent with analytic procedures used to test other theories of intention (Bagozzi & Warshaw, 1990).

2.4. Questionnaire translation

As all of the measures were derived and adapted from research on English-speaking samples, we adopted a rigorous translation procedure to develop a language-specific questionnaire for use in Pakistan schools. We used standardized back-translation techniques involving the construction of a draft version of the questionnaire items in Urdu by a bilingual translator (Brislin, 1986). We selected Urdu as the language for the questionnaires as this is the *lingua franca* of Pakistan and the language of instruction in the schools from which participants were recruited. The initial draft was vetted by two independent and proficient bilingual translators who translated the questionnaires back into English. We then compared the back-translated versions with the original English version and any inconsistencies, errors, biases, and incongruences highlighted. These inconsistencies were removed in a further translation and the back-translation comparison process was repeated until the versions were semantically identical, as recommended by Bracken and Barona (1991).

2.5. Data analysis

We analyzed the data using variance-based structural equation modeling (VB-SEM), also known as Partial Least Squares analysis, with the Warp PLS v.4.0 statistical software (Kock, 2013). VB-SEM is similar to covariance-based SEM analyses in that it explicitly models measurement error through the construction of latent factors. However, unlike methods used in covariance-based SEM, the partial least-squares algorithm is based on ranked data and is, therefore, distribution-free (i.e., the estimation is less affected by the complexity of the model, small sample size, or non-normality of the data). This makes it ideal for use with the current data set given the complexity of the model and the greater statistical power offered by the VB-SEM method (Reinartz, Haenlein, & Henseler, 2009). In the proposed model, each trans-contextual model construct was represented as a latent variable indicated by the set of items proposed to measure that construct. All latent variables were indicated by multiple items with the exception of participants' mathematics homework grades and past mathematics homework effort which were indicated by single items. The hypothesized relations among the variables in the trans-contextual model summarized in Figure 2 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.

The analysis permits evaluation of the model at the measurement level (i.e., relations between the items used to measure the proposed trans-contextual model constructs and the proposed latent factors representing the constructs), and at the structural level (i.e., relations among the latent constructs as proposed in the trans-contextual model specified a priori) according to published criteria for VB-SEM models (Esposito Vinzi, Chin, Henseler, & Wang, 2010). At the measurement level, construct validity of the latent factors will be established using the average variance extracted (AVE) and composite reliability coefficients (ρ), which should exceed .500 and .700, respectively. Discriminant validity is supported when the square-root of the AVE for each latent variable exceeds its correlation coefficient with other latent variables (Esposito Vinzi et al., 2010). In addition, the potential for multicollinearity was

checked using the full collinearity variance inflation factor (AFVIF) with values lower than 3.300 indicative of no issues with multicollinearity (Kock, 2013). At the structural level, adequacy of the hypothesized pattern of relations among the model constructs was established using an overall goodness-of-fit (GoF) index given by the square root of the product of the AVE and average R^2 for the model (.100, .250, and .360 correspond to small, medium, and large effect sizes) (Tenenhaus, Vinzi, Chatelin, & Lauro, 2005). Further information on the adequacy of the model is provided by the average path coefficient (APC) and average R^2 (ARS) coefficient across the model, both of which should be statistically significantly different from zero. In order to verify the robustness of the model parameters (i.e., the path estimates representing relations among the variables), a bootstrapping resampling technique with 100 replications was utilized to estimate stable and reliable averaged path estimates and associated significance levels (Kock, 2013). Further, to mitigate the influence of outliers without compromising sample size, the analysis was conducted with ranked data to reduce outlier value distances. Hypothesized mediation effects were tested by calculating indirect effects from a bootstrapped resampling method (Kock, 2013). Mediation was confirmed by the presence of a statistically significant bootstrapped indirect effect, with the direct effect being either statistically significant (indicative of partial mediation) or non-significant (indicative of complete mediation).

3. Results

3.1. Participants

As class attendance was compulsory with low rates of absenteeism and none of the students' parents refused consent for their child to participate, we were able to attain a very high retention rate across the three occasions of data collection. Only four participants dropped out due to absence resulting in a final sample size of 216 participants (boys = 96, girls = 120; M age = 13.43, $SD = 0.77$). The extremely small dropout rate rendered formal comparisons for attrition bias redundant. All participants were ethnic Pakistani of Muslim faith consistent with

the ethnic profile of the Multan region in which 98% of inhabitants are Muslims. Participants spoke one of the three of the major regional languages as their first language: 38.42% of the sample spoke Punjabi, 34.72% spoke Saraiki, and 26.85% spoke Urdu. All of the participants were, however, fluent Urdu speakers. A substantial majority of the participants (68.52%) were urban dwelling, defined as living within the bounds of the Multan conurbation, with the remainder living in rural or semi-rural environs. A majority of the main caregivers of the participants were employed in occupations classified as blue-collar (56.48%), defined as working in unskilled or semi-skilled jobs, with the remainder classified as white-collar, defined as working in skilled or professional jobs.

3.2. Preliminary analyses

Measurement-level statistics of the VB-SEM of the trans-contextual model data were subject to initial examination to ensure the latent variables met construct and discriminant validity criteria. Composite reliability coefficients, AVE for the factors, and factor intercorrelations are presented in Table 2. Reliability coefficients exceeded the .700 criterion for the factors included in the model. In all cases, the square root of the AVE for each latent variable exceeded the correlation between the variable and all other variables. Inspection of the full colinearity variance inflation factor for each item revealed values equal to, or lower than, the 3.300 cut-off criterion indicating no problems with multicollinearity (Kock, 2013).

3.3. Structural equation model

Overall, the model indicated adequate model fit with the model according to multiple recommended indices with large effect sizes (GoF = 0.651; APC = .311, $p < .001$; ARS = .528, $p < 0.001$; AFVIF = 2.737). In addition, the model accounted for a statistically significant amount of variance in the two key dependent variables, self-reported mathematics homework behavior ($R^2 = .542$) and homework grades ($R^2 = .415$). Standardized parameter estimates for the structural relations among the trans-contextual model factors in the proposed model are given in Figure 3.

Focusing on tests of sets of hypothesized effects in the model, perceived autonomy support had statistically significant effects on the autonomous forms of motivation toward mathematics in school (intrinsic motivation, H_{1a} , $\beta = .562$, $p < .001$; identified regulation, H_{1b} , $\beta = .539$, $p < .001$). There were statistically significant trans-contextual effects of the autonomous forms of regulation for mathematics (intrinsic motivation, H_{2a} , $\beta = .745$, $p < .001$; identified regulation, H_{2b} , $\beta = .542$, $p < .001$) between the school and out-of-school contexts. As predicted, there were statistically significant indirect effects of perceived autonomy support for mathematics activities in school on autonomous forms of motivation toward homework in the out-of-school context mediated by the matching autonomous forms of motivation for the school context (intrinsic motivation, H_{2c} , $\beta = .418$, $p < .001$; identified regulation, H_{2d} , $\beta = .292$, $p < .01$).

In the out-of-school context, there were statistically significant effects for autonomous forms of motivation for homework on attitudes (intrinsic motivation, H_{3a} , $\beta = .461$, $p < .001$; identified regulation, H_{3b} , $\beta = .313$, $p < .001$) and perceived behavioral control (intrinsic motivation, H_{3c} , $\beta = .571$, $p < .001$; identified regulation, H_{3d} , $\beta = .190$, $p < .001$), as predicted. There were statistically significant effects of the autonomous forms of motivation on subjective norms (intrinsic motivation, H_{3e} , $\beta = .180$, $p < .001$; identified regulation, H_{3f} , $\beta = .734$, $p < .001$), which was contrary to our hypotheses.

Attitudes and subjective norms (H_{4a} , $\beta = .531$, $p < .001$; H_{4c} , $\beta = .317$, $p < .001$) exhibited statistically significant effects on intention to complete mathematics homework as predicted, but there was no effect of perceived behavioral control on intention (H_{4b}), which led us to reject the hypothesis. There were statistically significant indirect effects of autonomous forms of motivation for the out-of-school context on intentions mediated by attitude (intrinsic motivation, H_{4d} , $\beta = .245$, $p < .05$; identified regulation, H_{4e} , $\beta = .166$, $p < .05$) but not for perceived behavioral control (intrinsic motivation, H_{4f} ; identified regulation, H_{4g}), which led us

to reject these hypotheses. Consistent with this expectation, our hypothesized direct effect of perceived autonomy support on intentions was not statistically significant (H_{4h}).

The hypothesized effects of intention on the two outcome variables mathematics homework (H_{5a} , $\beta = .210$, $p < .001$) and grades (H_{5b} , $\beta = .313$, $p < .001$) were statistically significant. Perceived behavioral control was also statistically significantly and directly related to mathematics homework behavior (H_{5c} , $\beta = .410$, $p < .001$) and grades (H_{5d} , $\beta = .409$, $p < .001$). There were also statistically significant indirect effects of the autonomous forms of motivation in the homework context on mathematics homework behavior (identified regulation, $\beta = .081$, $p = .040$) and grades (identified regulation, $\beta = .121$, $p = .005$; intrinsic motivation, $\beta = .093$, $p = .023$) through the antecedents of intention (attitudes, subjective norms, perceived behavioral control) and intention. The largest mediated effect of intrinsic motivation on the behavioral outcomes was through attitude and intention (grades, H_{5f} , $\beta = .082$, $p = .006$), consistent with hypotheses. There was no indirect effect of intrinsic motivation on homework behavior leading to a rejection of this hypothesis (H_{5e}). The largest mediated effects for identified regulation on the homework outcome variables were also through attitude and intention (homework behavior, H_{5i} , $\beta = .037$, $p = .039$; grades, H_{5j} , $\beta = .056$, $p = .044$), as predicted. Given that the effect of perceived behavioral control on intentions was not statistically significant, the hypothesized mediation effects involving perceived behavioral control (H_{5g} , H_{5h} , H_{5k} , H_{5l}) were rejected.

There was also an indirect effect of identified regulation on intention mediated by subjective norms ($\beta = .311$, $p < .05$), contrary to predictions. In addition, although not originally hypothesized, perceived behavioral control also mediated the effects of intrinsic motivation (homework behavior, $\beta = .235$, $p < .001$; grades, $\beta = .234$, $p < .001$) and identified regulation (homework behavior, $\beta = .079$, $p = .024$; grades, $\beta = .079$, $p = .025$) on homework outcomes. The effect was due to the unexpected statistically significant direct effects of perceived behavioral control on the two behavioral variables. Finally, we found statistically

significant indirect effects of perceived autonomy support on mathematics behavior (H_{5m} , $\beta = .151$, $p = .002$) and grades (H_{5n} , $\beta = .165$, $p < .001$) mediated by the entire motivational sequence.

4. Discussion

The purpose of the present study was to apply the trans-contextual model of motivation to examine the process by which school students' motivation toward mathematics activities in the classroom in an educational context was related to motivation, intention, and behavioral outcomes with respect to mathematics homework in an out-of-school context. Integrating the perspectives of multiple theories, the model proposed that perceived support for forms of autonomous motivation toward mathematics learning activities in school would be related to autonomous motivation in school and autonomous motivation for mathematics homework in an out-of-school context, the proposed trans-contextual effects. Autonomous forms of motivation toward mathematics homework were also hypothesized to be related to the social-cognitive antecedents of behavioral outcomes; attitudes, subjective norms, perceived behavioral control, and intentions. Autonomous motivation was predicted to be associated with the outcomes themselves, namely, mathematics homework behavior and homework grades, mediated by the social-cognitive variables. The study extends previous research by examining the motivational transfer effects for an academic discipline and on an objective outcome variable related to behavior, namely, school grades.

Our test of the model in high-school students provided support for the predictions of the hypothesized effects in the model for mathematics learning activities in school and out-of-school contexts. Within the school context, perceived autonomy support for mathematics activities in the classroom was related to autonomous forms of motivation, intrinsic motivation and identified regulation, toward mathematics activities in the same context. Forms of autonomous motivation toward mathematics activities in the educational context were associated with matched forms of autonomous motivation toward mathematics homework in

the out-of-school context. Autonomous forms of motivation in the out-of-school context were statistically significantly related to attitudes and perceived behavioral control. Attitudes mediated the effects of autonomous motivation on intentions to do mathematics homework. However, contrary to predictions, we did not find a mediated effect of autonomous motivation on intentions in the out-of-school context through perceived behavioral control because the latter variable was unrelated to intentions. There were also effects of autonomous forms of motivation on subjective norms and this variable also mediated the effect of identified regulation on intention. Intention predicted students' self-reported mathematics homework behavior and mathematics grades. Perceived behavioral control also directly predicted the behavioral outcomes variables. The proposed motivational sequence mediated the distal effects of perceived autonomy support and autonomous motivation in both educational and out-of-school contexts on the behavioral outcomes.

Current results are closely aligned with the pattern of effects found in previous tests of the trans-contextual model in other contexts (Hagger et al., 2005; Hagger et al., 2003; Hagger et al., 2009). The main predictions of the model (Figure 1) including the effect of perceived autonomy support on autonomous forms of motivation in an educational context, the trans-contextual relation between autonomous forms of motivation across educational and out-of-school contexts, and the effects of autonomous forms of motivation in the out-of-school context on intentions and actual behavior with respect to mathematics homework were all supported. Previous tests of the model have exclusively focused on fostering leisure-time physical activity, a non-academic behavior, as a consequence of perceived autonomy support and autonomous motivation toward physical activity in physical education lessons (Hagger et al., 2003). Current results provide the first evidence that the model can be extended to academic disciplines across educational and out-of-school contexts. This is important theoretically as it points to the possibility that the proposed pattern of effects are likely to be general and applicable to other academic domains (Hagger & Chatzisarantis, 2012). The

proposal of the generalizability of effects has been put forward in previous research when testing the trans-contextual model across samples from multiple national groups, suggesting that the motivational and social cognitive variables and their proposed relations are universal (Hagger et al., 2005; Hagger et al., 2009). The proposition is consistent with assumptions of the component theories of the trans-contextual model; self-determination theory (Deci & Ryan, 2000) and the theory of planned behavior (Ajzen, 1991) in that the hypothesized effects generalize to multiple contexts and behaviors. The generalizability of effects has also been supported in a meta-analysis that has shown consistent patterns for the hypothesized relations between constructs of the integrated model across multiple behaviors and domains (Hagger & Chatzisarantis, 2009).

Consistency in the proposed patterns of the model across studies notwithstanding, the current research also identified unique effects that led to the rejection of a few model hypotheses. The first was the statistically significant effects of the autonomous forms of motivation on subjective norms. Our original hypothesis was that this effect would be null, as subjective norms is typically conceptualized as beliefs regarding social pressure to act in future and, therefore, more akin to controlling forms of motivation. A possible explanation for this pathway is that beliefs reflecting normative desires regarding behavior like homework may reflect more internalized beliefs regarding the expectations of significant others. Internalization is a process derived from self-determination theory in which individuals view the commands and instructions of others, that would normally be interpreted as controlling, as important to their goals and, therefore, freely choose to conform to desires of significant others (Deci, Eghrari, Patrick, & Leone, 1994; Ryan & Connell, 1989). In this case students may have believed the desires of significant others like teachers or parents as supporting their autonomous goals and therefore those beliefs were in line with identified reasons for doing homework.

The cultural norms of the sample may have been a possible reason why the desires of significant others were internalized in the present study. There is evidence to suggest that individuals from nations with interdependent or collectivist cultural values (Iyengar & Lepper, 1999) and those that endorse collectivist norms (Hagger, Rentzelas, & Chatzisarantis, 2014) are likely to experience intrinsic motivation even when being told what to do by significant others. It is therefore possible that the unique cultural characteristics of the current sample may have influenced the pathways through which autonomous motivation affects intentions and mathematics outcomes in the current study. It must, however, be stressed that this notion is entirely speculative as we did not collect any data on the cultural orientations of the participants during the course of the present study. Furthermore, research examining the invariance of trans-contextual model effects across multiple samples from different cultural backgrounds has generally supported the pattern of effects and did not point to any robust culture-specific findings (Hagger et al., 2005; Hagger et al., 2009). Of course, one must consider the caveat that the latter findings are in the context of physical education and leisure-time physical activity rather than in a mathematics context. We cannot, therefore, ascertain whether the variation of effects is due to the cultural orientation, academic context, or an idiosyncratic finding in this particular sample. We look to future research to conduct more formal tests of these potential moderating variables and make comparisons across samples from different cultural backgrounds as well as different academic subjects.

Another unique finding was the lack of an effect for perceived behavioral control on intentions. Instead the effects of perceived behavioral control on behavioral outcomes were direct. Perceived behavioral control is, typically, a statistically significant predictor of intentions in most tests of the theory of planned behavior and the trans-contextual model (Armitage & Conner, 2001; McEachan et al., 2012). The proposed reason for the lack of an indirect effect and presence of direct effect is that perceived behavioral control closely approximates actual control and barriers, and therefore is not involved in intentional processes,

but affects behavior directly (Ajzen, 1991). This is unlikely to be the case in the current work. More likely it seems that actual control is aligned with autonomous reasons for participating in mathematics homework behavior, as evidenced by the fact that it is directly predicted by both forms of autonomous motivation, and possibly represents beliefs about competence for mathematics homework (Hagger, Chatzisarantis, & Harris, 2006b). These are transmitted directly on to behavioral outcomes, homework behavior and grades, independent of intentions. This may be because competence engenders approach responses to autonomous actions independent of the need for deliberation or intentional processes. It may be that while beliefs about competence are relevant to intentional processes for behaviors outside the education domain such as physical activity and diet (Hagger et al., 2006a, 2006b), within the academic domain, competence leads to more spontaneous participation in activities when the opportunity arises with less deliberation. There is research adopting implicit measures of autonomous motivation demonstrating that some behaviors are controlled, partly, by automatic processes (Keatley, Clarke, & Hagger, 2013; Levesque & Pelletier, 2003). Further, for behaviors where the cues or beliefs that lead to action are well learned or linked to a behavioral response, less intentional thought and deliberation is required and that may be the case for educational activities (Gollwitzer, 1999; Hagger & Luszczynska, 2014). However, the role of implicit processes has yet to be elucidated in the current context and model. With the exception of these two deviations, the current pattern of effects for mathematics activities in the class and homework is consistent with the proposed model and previous tests.

The current research has important implications for practice. It responds to a fundamental question posed by many educators: does the instruction of teachers in school affect students' learning behavior outside of school? Findings of the present research provide a possible response by demonstrating that perceived teacher support for autonomous motivation toward mathematics educational activities in school is related to autonomous motivation toward mathematics activities in class and, most importantly, toward self-directed mathematics

learning activities outside of school. In particular, the current research demonstrates the likely effectiveness that interventions to promote autonomy-supportive behaviors among teachers may have in fostering autonomous motivation toward academic behaviors not only in the classroom but also in out-of-school contexts. Autonomous motivation can be fostered through a number of key techniques (Reeve & Jang, 2006). These techniques include content and behaviors adopted by teachers and educators during their lessons (McLachlan & Hagger, 2010; Reeve & Jang, 2006). Examples of autonomy-supportive techniques include providing choice and a meaningful rationale for activities, offering encouragement and positive feedback, avoiding controlling directives and commands, acknowledging students' perspectives, offering hints, and promoting an exploratory approach on how to progress with tasks. Training programs have been developed to instruct teachers on how to employ more autonomy-supportive techniques in lessons (Cheon, Reeve, & Moon, 2012; McLachlan & Hagger, 2010).

The current model also indicates that interventions targeting key variables in the out-of-school context may also be effective in bolstering intentions to participate in self-directed learning activities like completing homework assignments. Interventions targeting an increase in autonomous motivation or attitudes or perceptions of control are likely to have an effect on behavioral outcomes as these variables have the strongest effect on behavior. Intervention techniques to promote autonomous motivation among students toward educational activities in an out-of-school context may target other sources such as parents but use similar techniques to those used by teachers in the educational context (Harackiewicz, Rozek, Hulleman, & Hyde, 2012). In fact, there is evidence that parental autonomy support has a pervasive effect on autonomous motivation toward out-of-school activities (Hagger et al., 2009). There are also means to promote increased attitudes and perceived behavioral control from the theory of planned behavior by presenting messages consistent with salient beliefs (Chatzisarantis & Hagger, 2005). The trans-contextual model can therefore serve as a basis for intervention in both educational and out-of-school contexts. School-based interventions may, however, be

more efficient and feasible as they enable educators greater reach and control in conveying intervention messages to school students.

5. Conclusion, strengths, limitations and future directions

The current investigation has a number of strengths. It is unique in applying the trans-contextual model to an academic discipline, namely mathematics activities and homework, across education and out-of-school contexts. It adopts an appropriate prospective three-wave design that has been previously supported, validated self-report measures of study constructs, optimal multivariate statistical techniques with latent variables, and an objective behavioral outcome measure in students homework grades. These design features aim to maximize the validity and accuracy of the measures used and minimize methodological variance. However, it would be remiss not to acknowledge some of the limitations of the study. First, although we adopted an appropriate sample in schools that fit the demographic profile of children in the Multan region in Pakistan, there is a need to replicate the model in additional samples and in school children from other national groups before definitive conclusions regarding generalizability can be made. Second, we did not include a cultural orientation measure such as scales tapping collectivist and individualist or independent and interdependent norms. Collecting data on cultural orientations may have provided preliminary information as to whether the current sample endorsed values that could potentially moderate the proposed model effects in comparisons with other national groups. Finally, although we conducted a prospective analysis using data from multiple time points, current findings are correlational and, therefore, carry with them difficulties with regard to inference of causality (Bagozzi, 2010). Our call for intervention or experimental studies that manipulate key variables within the nomological network of relations of the model is warranted to better confirm the hypothesized direction of effects in the proposed motivational sequence.

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Table 1

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

H	Independent variable	Dependent variable	Mediator/mediators	Prediction ^a
H _{1a}	Perceived autonomy support	Intrinsic motivation (s)		Effect
H _{1b}	Perceived autonomy support	Identified regulation (s)		Effect
H _{2a}	Intrinsic motivation (s)	Intrinsic motivation (h)		Effect
H _{2b}	Identified regulation (s)	Identified regulation (h)		Effect
H _{2c}	Perceived autonomy support	Intrinsic motivation (h)	Intrinsic motivation (s)	Effect
H _{2d}	Perceived autonomy support	Identified regulation (h)	Identified regulation (s)	Effect
H _{3a}	Intrinsic motivation (h)	Attitude		Effect
H _{3b}	Identified regulation (h)	Attitude		Effect
H _{3c}	Intrinsic motivation (h)	PBC		Effect
H _{3d}	Identified regulation (h)	PBC		Effect
H _{3e}	Intrinsic motivation (h)	Subjective norms		No effect
H _{3f}	Identified regulation (h)	Subjective norms		No effect
H _{4a}	Attitude	Intention		Effect
H _{4b}	PBC	Intention		Effect
H _{4c}	Subjective norms	Intention		Effect
H _{4d}	Intrinsic motivation (h)	Intention	Attitude	Effect
H _{4e}	Identified regulation (h)	Intention	Attitude	Effect
H _{4f}	Intrinsic motivation (h)	Intention	PBC	Effect
H _{4g}	Identified regulation (h)	Intention	PBC	Effect
H _{4h}	Perceived autonomy support	Intention		No effect
H _{5a}	Intention	Mathematics homework behavior		Effect
H _{5b}	Intention	Grades		Effect
H _{5c}	PBC	Mathematics homework behavior		Effect
H _{5d}	PBC	Grades		Effect
H _{5e}	Intrinsic motivation (h)	Mathematics homework behavior	Attitude Intention	Effect
H _{5f}	Intrinsic motivation (h)	Grades	Attitude Intention	Effect
H _{5g}	Intrinsic motivation (h)	Mathematics homework behavior	PBC Intention	Effect
H _{5h}	Intrinsic motivation (h)	Grades	PBC Intention	Effect
H _{5i}	Identified regulation (h)	Mathematics homework behavior	Attitude Intention	Effect
H _{5j}	Identified regulation (h)	Grades	Attitude Intention	Effect
H _{5k}	Identified regulation (h)	Mathematics homework behavior	PBC Intention	Effect
H _{5l}	Identified regulation (h)	Grades	PBC Intention	Effect
H _{5m}	Perceived autonomy support	Mathematics homework behavior	Autonomous motivation (s) Autonomous motivation (h) Intention antecedents	Effect

H _{5n}	Perceived autonomy support	Grades	Intention Autonomous motivation (s) Autonomous motivation (h) Intention antecedents Intention	Effect
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Note. H = hypothesis; s = school or educational context; h = home or out-of-school context;

PBC = perceived behavioral control. ^aDenotes whether the hypothesis specifies an effect or no effect.

Table 2

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

Variable	ρ	AVE	R ²	1	2	3	4	5	6	7	8	9	10	11	12
1. Perceived autonomy support (school)	0.931	0.529	0.351	(0.727)											
2. Identified regulation (school)	0.924	0.802	0.413	0.587***	(0.896)										
3. Intrinsic motivation (school)	0.896	0.742	0.479	0.595***	0.674***	(0.862)									
4. Identified regulation (homework)	0.911	0.774	0.474	0.738***	0.579***	0.598***	(0.880)								
5. Intrinsic motivation (homework)	0.922	0.797	0.647	0.709***	0.598***	0.648***	0.774***	(0.892)							
6. Attitude	0.938	0.753	0.578	0.712***	0.605***	0.613***	0.668***	0.690***	(0.868)						
7. Subjective norm	0.938	0.835	0.785	0.769***	0.532***	0.622***	0.763***	0.763***	0.686***	(0.914)					
8. Perceived behavioral control	0.915	0.782	0.545	0.633***	0.521***	0.533***	0.635***	0.603***	0.650***	0.683***	(0.884)				
9. Intention	0.913	0.778	0.549	0.609***	0.564***	0.539***	0.692***	0.688***	0.682***	0.651***	0.589***	(0.882)			
10. Mathematics homework behavior	0.918	0.848	0.542	0.602***	0.509***	0.586***	0.600***	0.657***	0.617***	0.624***	0.628***	0.582***	(0.921)		
11. Homework grades	1.000	1.000	0.415	0.494***	0.466***	0.333***	0.529***	0.518***	0.539***	0.495***	0.536***	0.559***	0.487***	(1.000)	
12. Past homework effort	1.000	1.000	–	0.424***	0.360***	0.469***	0.380***	0.438***	0.382***	0.407***	0.328***	0.368***	0.478***	0.248***	(1.000)

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

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

Figure captions

Figure 1. The Trans-Contextual Model.

Figure 2. Diagram Summarizing Hypothesized Effects in the Proposed Trans-Contextual Model.

Note.

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

Figure 3. Standardized Path Coefficients for Structural Equation Model of Hypothesized Relations among Trans-Contextual Model Constructs.

Note.

Only statistically significant paths shown. Effects of past mathematics homework effort on each variable in the model omitted for clarity. Paths freely estimated in the model but not depicted in diagram: past mathematics homework effort \rightarrow perceived autonomy support (school) ($\beta = .593, p < .001$); past mathematics homework effort \rightarrow identified regulation (school) ($\beta = .142, p = .006$); past mathematics homework effort \rightarrow intrinsic motivation (school) ($\beta = .181, p < .001$); past mathematics homework effort \rightarrow identified regulation (homework) ($\beta = .210, p < .001$); past mathematics homework effort \rightarrow intrinsic motivation (homework) ($\beta = .086, p = .065$); past mathematics homework effort \rightarrow attitude ($\beta = -.006, p = .460$); past mathematics homework effort \rightarrow subjective norm ($\beta = -.032, p = .284$); past mathematics homework effort \rightarrow perceived behavioral control ($\beta = -.007, p = .450$); past

mathematics homework effort \rightarrow intention ($\beta = .037, p = .257$); past mathematics homework effort \rightarrow mathematics homework behavior ($\beta = .216, p < .001$); past mathematics homework effort \rightarrow homework grades ($\beta = -.048, p = .198$).





