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Motivational predictors of students' participation in out-of-school learning activities and academic attainment in science: An application of the trans-contextual model using Bayesian path analysis

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ABSTRACT

Given the shortfall in students studying science, promotion of motivation and engagement in science education is a priority. The current study applied the trans-contextual model to study the motivational predictors of participation in science learning activities in secondary-school students. In a three-wave design, secondary-school students completed measures of perceived autonomy support, autonomous and controlled motivation, social-cognitive beliefs (attitudes, subjective norms, perceived control), intentions, and self-reported participation in out-of-school science learning activities. Five-weeks later, students self-reported their science learning activities. Students' science grades over the semester period were obtained. Bayesian path analyses supported model hypotheses: in-school autonomous motivation predicted out-of-school autonomous motivation, beliefs, intentions, science activity participation, and science grades. Specifying informative priors for key model relations using Bayesian analysis yielded greater precision in estimates. Findings provide evidence for a link between students' autonomous motivation toward science activities across contexts and may inform interventions promoting motivation and participation in science activities.

1. Introduction

Governmental and educational organisations have identified the importance of education in science, technology, engineering, and mathematics (STEM) subjects as drivers for economic growth (Anlezark, Lim, Semo, & Nguyen, 2008). Given recent evidence that more students are tending to study subjects outside science-based disciplines at secondary school and university (Hodgen, Kuchemann, Brown, & Coe, 2009; NCES, 2012), and a documented shortfall in enrolment for degree and vocational programmes in STEM subjects (Marginson, Tytler, Freeman, & Roberts, 2013), the promotion of engagement in STEM subjects at all levels of education is viewed as a priority. Promoting engagement in STEM-related subjects, including science, in school may address the shortfall by providing students with the necessary skills, confidence, and motivation to undertake further training in STEM-related subjects in secondary and higher education.

Student motivation plays a key role in determining engagement and attainment in school science lessons. Research has demonstrated that students' motivation to learn in the classroom is strongly related to their engagement in lessons and to adaptive learning outcomes including interest in the subject matter and academic attainment (Steinmayr & Spinath, 2009). In particular, intrinsic and autonomous forms of motivation have been shown to be related to students' engagement in lessons and better grades (Deci, Vallerand, Pelletier, & Ryan, 1991; Lepper, Corpus, & Iyengar, 2005; Pintrich & Degroot, 1990). Autonomous motivation is adaptive because students tend to engage in educational activities out of the inherent interest and enjoyment derived from the activities or because the activities service a goal or outcome that is self-referenced and related to the student true sense of self. Importantly, autonomously motivated students engage in learning without the need for any external reinforcement or contingencies (Reeve, 2002). Teachers in an educational context have a key role to play in fostering autonomous motivation in the classroom environment through actions and behaviors that are autonomy supportive. Students in autonomy-supportive learning environments report greater autonomous motivation in class and better learning outcomes (Reeve, Bolt, &

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Cai, 1999; Reeve & Jang, 2006). In addition, students that perceive teachers to be autonomy supportive also have adaptive educational outcomes in the classroom (Ferguson, Kasser, & Jahng, 2011; Guay, Boggiano, & Vallerand, 2001).

One possible mechanism by which autonomy support in the classroom environment leads to better educational outcomes is through greater autonomous motivation toward, and participation in, learning activities outside of class. However, there is little research examining the effect of perceived support for autonomous motivation in the classroom context on motivation toward, and participation in, learning activities outside of class (Hagger & Chatzisarantis, 2012; Vallerand, 1991). Such activities may include, but are not limited to, formal activities directed or promoted by the teacher such as homework or additional recommended activities to support the curriculum, or informal learning activities in which students independently participate. In the current study, we used the trans-contextual model (Hagger & Chatzisarantis, 2016), an integrated multi-theory model of motivation, to test the effects of secondary-school students' perceived autonomy support toward science activities in class on autonomous motivation, beliefs, and intentions toward, and actual participation in, science learning activities outside of school set by the teacher. These learning activities are tailored to match the current school science curriculum and aimed at promoting students' retention of science knowledge and skills covered in class. We also adopted a Bayesian analytic approach which allowed us to test the proposed effects when accounting for previous knowledge derived from research applying the trans-contextual model in other educational contexts. The research is expected to make an original contribution to understanding the processes by which perceived autonomy support and autonomous motivation toward science activities in the classroom relates to autonomous motivation toward engaging in science learning activities outside of school.

1.1. The trans-contextual model

The trans-contextual model outlines to processes by which school students' autonomous motivation toward in-school educational activities relate to autonomous motivation, intentions, and actual participation in related activities in an out-of-school context (Hagger, Chatzisarantis, Culverhouse, & Biddle, 2003). The model derives its hypotheses from two influential psychological theories, self-determination theory (Deci & Ryan, 1985) and the theory of planned behavior (Ajzen, 1991, 2015), with additional hypotheses derived from Vallerand's (2007) hierarchical model of intrinsic and extrinsic motivation. In the next section, we outline the key hypotheses of the trans-contextual model and how the model provides a basis for understanding motivation in educational and out-of-school contexts. Hypotheses of the trans-contextual model are summarized in Table 1 and a diagram of model predictions is provided in Fig. 1. These should be used as a guide to support our description of the model hypotheses.

1.1.1. Key hypotheses of the model

Consistent with the key premise of self-determination theory (Deci & Ryan, 1985, 2000), the trans-contextual model assumes that autonomous motivation will likely lead to persistence on in-class activities in educational contexts and adaptive outcomes such as academic attainment (Reeve et al., 1999). Science teachers can foster autonomous motivation by adopting autonomy-supportive actions and behaviors (McLachlan & Hagger, 2010; Reeve & Jang, 2006). In the absence of observations of teachers' actual autonomy support, students' perceived autonomy support serves as a proxy measure. The proposed effect of students' perceived autonomy support on autonomous motivation toward activities in science lessons forms the first hypothesis of the trans-contextual model (H_1).

Fundamental to the trans-contextual model is the proposal that autonomous motivation toward educational activities in the classroom will predict autonomous motivation toward related activities in an out-

Table 1
Summary of hypothesized direct and indirect effects in the trans-contextual model for school and out-of-school science activities.

H	Independent variable	Dependent variable	Mediator(s)
Direct effects			
H_1	Perceived autonomy support	Autonomous motivation (s)	–
H_2	Autonomous motivation (s)	Autonomous motivation (os)	–
H_3	Controlled motivation (s)	Controlled motivation (os)	–
H_4	Autonomous motivation (os)	Attitude	–
H_5	Autonomous motivation (os)	PBC	–
H_6	Controlled motivation (os)	Subjective norm	–
H_7	Attitude	Intention	–
H_8	Subjective norm	Intention	–
H_9	PBC	Intention	–
H_{10}	Intention	Science behavior	–
H_{11}	PBC	Science behavior	–
H_{12}	Intention	Science grades	–
H_{13}	PBC	Science grades	–
Indirect effects			
H_{14}	Perceived autonomy support	Autonomous motivation (os)	Autonomous motivation (s)
H_{15}	Autonomous motivation (s)	Intention	Autonomous motivation (os) Attitude
H_{16}	Autonomous motivation (s)	Intention	Autonomous motivation (os) PBC
H_{17}	Controlled motivation (s)	Intention	Controlled motivation (os) Subjective norm
H_{18}	Autonomous motivation (s)	Science behavior	Autonomous motivation (os) Attitude Intention
H_{19}	Autonomous motivation (s)	Science behavior	Autonomous motivation (os) PBC Intention
H_{20}	Autonomous motivation (s)	Science grades	Autonomous motivation (os) Attitude Intention
H_{21}	Autonomous motivation (s)	Science grades	Autonomous motivation (os) PBC Intention
H_{22}	Controlled motivation (s)	Science behavior	Controlled motivation (os) Subjective norm Intention
H_{23}	Controlled motivation (s)	Science grades	Controlled motivation (os) PBC Intention
H_{24}	Autonomous motivation (os)	Intention	Attitude
H_{25}	Autonomous motivation (os)	Intention	PBC
H_{26}	Controlled motivation (os)	Intention	Subjective norm
H_{27}	Autonomous motivation (os)	Science behavior	Attitude Intention
H_{28}	Autonomous motivation (os)	Science behavior	PBC Intention
H_{29}	Autonomous motivation (os)	Science grades	Attitude Intention
H_{30}	Autonomous motivation (os)	Science grades	PBC Intention
H_{31}	Controlled motivation (os)	Science behavior	Subjective norm Intention

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