Learning and Individual Differences 91 (2021) 102057

Contents lists available at ScienceDirect

Learning and Individual Differences

journal homepage: www.elsevier.com/locate/lindif

Student experience of creativity in Australian high school classrooms: A componential model

Paul Ginns [a,*], Kelly Freebody [a], Michael Anderson [a], Peter O'Connor [b]

[a] Sydney School of Education and Social Work, The University of Sydney, NSW 2006, Australia
[b] Faculty of Education and Social Work, The University of Auckland, Auckland, New Zealand

ARTICLE INFO

Keywords:
Componential model of creativity
High school
Creativity supports
Intrinsic and extraneous motivation
Academic and creative self-efficacy

ABSTRACT

Drawing on the componential theory of creativity, we report on the development of a model for understanding students' experiences of creative school environments, based on survey responses from Grade 7 and 9 Australian students ($N = 2538$) across 13 high schools. Confirmatory factor analysis was used to test for construct validity of scales, followed by structural equation modeling to estimate the fit of the hypothesised model to the data, and estimate direct and indirect relations between variables. Consistent with predictions based on the componential model, students' perceptions of the extent to which creativity was supported through classroom work had substantial direct relations with intrinsic motivation and creative self-efficacy. Also consistent with predictions, intrinsic motivation acted as a mediating variable for a number of pathways in the model. Demographic covariates were generally less salient than personality covariates. Implications for educational practice and future research are discussed.

1. Introduction

There is increasing recognition that schools can and should develop students' creative capacities (Beghetto et al., 2014; OECD, 2019a). Achieving this goal is best served by a systems conception of creativity (Hennessey, 2015; Kupers et al., 2019), in which the development of such potential stems from the interaction of individual and social (including cultural) dimensions. Of the various models of creativity with such breadth of scope (e.g., Csikszentmihalyi, 1988; Rhodes, 1961), Amabile's (1983, 2018) componential model foregrounds the role of social-environmental forces in understanding how intra-individual factors, such as task motivation, domain-relevant skills, and creativity-relevant processes, combine to support progress towards a goal. Amabile's model has particular resonance for a consideration of creativity in schooling because of its close consideration of the impact of social environments on the key variable of intrinsic motivation – a perennial concern for educators. In the present study, key paths of the componential model (see Amabile, 2018, Fig. A) between the social environment, task motivation, domain-relevant skills, and creativity-relevant processes are tested across 13 Australian high schools. (Amabile's model stipulates additional processes relating these variables to problem identification, preparation, response generation, response validation and communication, and outcomes, feeding back to task motivation, not included in the present study.)

The study extends the relatively small empirical base of the componential model in secondary education in several ways. First, it expands the conceptualization and measurement of a social environment supporting creativity in school settings. Second, the study uses structural modeling to provide a stringent test of key pathways in the componential model, focusing on direct paths from social environment to domain-relevant skills and creativity-relevant processes, but also indirect associations with domain-relevant skills and creativity-relevant processes mediated through task motivation variables. In the sections below, theory and research on each of these elements of the componential model is reviewed, with an emphasis on the model's application to educational settings.

1.1. Social environment and task motivation

Reviewing research on children's and adolescents' creativity, Kupers et al. (2019) drew on Rhodes' (1961) seminal formulation to categorized theories of creativity according to their focus across *Person*, *Product*, *Process*, or *Press*, with Press referring to "the relationship between human beings and their environment" (p.308). Writing at the same time

* Corresponding author at: Sydney School of Education and Social Work, Education Building A35, The University of Sydney, NSW 2006, Australia.
E-mail address: paul.ginns@sydney.edu.au (P. Ginns).

https://doi.org/10.1016/j.lindif.2021.102057
Received 7 January 2021; Received in revised form 6 August 2021; Accepted 9 August 2021
Available online 18 August 2021

as Rhodes, Torrance (1961) discussed the qualities of the "creative relationship" between a teacher and student. In advocating for "being a guide, not a god", accepting students' limitations and assets creatively, a willingness to use "teachable moments", and generating a friendly environment based on respect and empathy rather than coercion, Torrance likewise argued strongly for the role of the social environment in promoting creativity, particularly in school settings.

Taking a social-psychological view of intrinsic motivation as engagement in a task as an end in itself, as opposed to as a means to an extrinsic goal, Amabile's (1983, 2018) model postulates a number of features of the *social environment* that may affect intrinsic and extrinsic motivation, and hence creativity. Early research by Deci (e.g., Deci, 1971, 1972) and Lepper and colleagues (e.g., Amabile et al., 1976; Lepper et al., 1973; Lepper & Greene, 1975) repeatedly demonstrated extrinsic constraints, such as lack of choice, rewards for performance, surveillance, and externally imposed deadlines, tended to lower intrinsic motivation; subsequent tests of the effects of such constraints (e.g., Amabile, 1979, 1982) also demonstrated negative effects on creative output. Drawing on these results, Amabile's (1983) Intrinsic Motivation Hypothesis of Creativity proposed that "The intrinsically motivated state is conducive to creativity, whereas the extrinsically motivated state is detrimental" (p. 91). Reflecting on explanations for these results often being explained through internal cognitive mechanisms, Hennessey (2015) called for more explicitly social considerations of such effects, distinguishing between "little-c" creative cultures of specific institutions or environments such as school environments and individual classrooms, versus "Big-C" creative cultures evinced by values, expectations and practices of nations, regions, or groups. Understanding the nature and development of "little-c" creative cultures, such as classrooms, mirrors calls for greater understanding of creativity's development at the individual level at a range of levels beyond "Big-C" (eminent) creativity and "little-c" (everyday) creativity, such as "mini-c" creativity that is inherent in the process of learning (Kaufman & Beghetto, 2009).

Large-scale empirical research relating students' perceptions of educational environments, task motivation, and/or creativity-relevant processes or outcomes is relatively scant, and has tended to be restricted to university samples. An early example of work in this area was Hill's (1991) development of a survey instrument identifying creativity-supportive factors in college classrooms, including perceptions of support for innovation, organization, competitiveness, peer support, student involvement, and teacher support. However, data presented by Amabile et al. (1994) noted the general level of support was weak for hypothesised correlations between these factors and student reports of intrinsic vs. extrinsic motivation; the relatively small sample in this study ($n = 98$) would have limited the power of these analyses. More recently, Choi (2004) tested a structural model linking individual characteristics including motivational and personality factors, social environment including supportive teaching and open group climate, and creativity-relevant processes including creative self-efficacy and creative intention, in predicting the creative performance of 430 US university students studying organizational behavior. Using path analysis, Chang et al. (2016) used the 8-item "organizational encouragement" scale developed by Amabile et al. (1996) as a measure of "perceived school support for creativity", in order to test effects of students' perceived school support for creativity and creative self-efficacy on students' individual creativity. Anderson et al. (2017) used exploratory and confirmatory factor analysis across two studies to derive associations between facets of American high school students' school engagement – including educational aspirations, relationships with teachers, and relationships with peers – and their self-reported creative ideation using the Runco Ideational Behavior Scale for Students (RIBS-C). Anderson et al. found substantial correlations between the above sets of constructs, consistent with theorizing regarding the importance of the social environment.

Widely used survey-based measures of workplace support for creativity tend to collect data on substantially more facets of social dimensions supporting creativity than in the studies described above. Thus, the Work Environment Scale (Amabile & Gryskiewicz, 1989) includes 8 scales considered to reflect environmental stimulants of creativity, and 4 scales considered to reflect obstacles. Likewise, the Situational Outlook Questionnaire (Isaksen, 2007) includes 9 scales reflecting various facets of organizational climate supporting change, innovation, and creativity. The present study sought to expand the range of educational environmental factors considered, drawing on 12 dimensions of creativity-supportive educational environments (see Table 1 for definitions and example items). The first 10 scales and items are based on Harris's (2016) framework for creativity supports in schools, along with the physical environments of schools as sites for creative learning (for a review, see Davies et al., 2013). Beyond these factors, as noted above, research based on the componential model has consistently identified perceptions of *autonomy* (versus constraint) as a key component of social environments supporting intrinsic motivation; the present study incorporates this factor into the overall model to be tested. Given the common focus of all Creative Classroom Index (CCI) items based on the item stem "In our classes, …", a hierarchical model was hypothesised, with the 12 hypothesised sub-factors loading on an overall "creative environment" factor. We consider these facets to be parts of an integrated experience of creative schooling; in the context of classroom-based education, then, teachers seeking to develop students' creativity would be expected to simultaneously use a wide range of approaches in tandem, rather than just one or two strategies. Such a focus on a singular higher-order construct (creative learning environments) thus distinguishes the proposed Creative Classrooms Index from other multiscale student experience survey instruments traversing more conceptually varied terrain (e.g., the What is Happening in This Class instrument's scales for Involvement, Investigation, Task Orientation, Cooperation, and Equity; see Dorman, 2003).

2. Domain-relevant skills

The next major component in Amabile's (2018) model, *domain-relevant skills*, encompasses "expertise, technical skill, and innate talent in the relevant domain(s) of endeavor" (Amabile & Pillemer, 2012, p.10). In the context of school-based education, expertise can be identified as academic achievement in the core curriculum, with knowledge and skills developed in areas such as language arts, mathematics, science, history, and geography providing a broad foundation for the development and expression of "little-c" or "mini-c" creativity in schoolwork (Kaufman & Beghetto, 2009). Measures such as grade point average generally provide reliable and valid summaries of student achievement across a range of subjects studied over a period of time (Richardson et al., 2012; Westrick et al., 2015). In school-based research, however, curriculum variation across schools and educational levels can present challenges to the use of such measures. Students' self-efficacy reports provide an alternative means of indexing domain-relevant skills, by asking students to rate how well they can learn a range of subject areas (Bandura, 2001). Using Gignac and Szodorai's (2016) benchmarks for correlation coefficient magnitudes in individual difference research, meta-analyses (e.g., Multon et al., 1991; Richardson et al., 2012) of correlations between academic self-efficacy and academic performance have found moderate to strong average correlations (0.21–0.41) between these variables across primary to tertiary educational levels.

2.1. Creativity-relevant processes

Following domain-relevant skills in the componential model are *creativity-relevant processes*, including a cognitive style supporting understanding of complexity and an ability to "break set" during problem-solving; knowledge of heuristics for generating new ideas; and a work style conducive to creativity, e.g., an ability to concentrate for extended periods, along with persistence in the face of challenges (Amabile, 2018). Amabile and Mueller (2008) present a range of methods for

Table 1
Social environment scales and example items.

Scale name	Description	Sample item	Related literature
Collaboration	To work in a group of two or more to develop shared understandings and achieve shared goals.	In our classes, students learn from working together, not just from the teacher.	Kyndt et al. (2013)
Problem-Solving	To identify and articulate problems and devise strategies for their solutions and/or management, considering consequences and outcomes.	In our classes, we are encouraged to think of different solutions to problems.	Treffinger et al. (1994)
Critical Thinking	To identify and articulate problems and devise strategies for their solutions and/or management, considering consequences and outcomes.	In our classes, we are learning to make up our own minds, not just accept what we are told.	Dwyer et al. (2014)
Playfulness	To use the imagination to create made-up worlds and situations. This capacity is often associated with enjoyment and fun.	In our classes, we have fun when we are learning.	Beghetto (2019)
Environment	The qualities of the environment, including physical, emotional and intellectual, and their adaptability for a diversity of classroom-based activities.	In our classes, our classroom are good spaces in which to learn.	Davies et al. (2013)
Divergent Thinking	To think differently about known problems; to evaluate the knowledge students have from different perspectives, and find new ways of understanding.	In our classes, we try different ideas to see if they work.	Kim (2011)
Innovation	To realise creative ideas in tangible ways.	In our classes, we try new ways of making or doing things.	Beyers (2010)
Discipline Knowledge	To develop expertise in a domain of knowledge that involves specialised content and process understandings.	In our classes, we aim to understand our work, not just memorize it.	Sweller (2009)
Risk-Taking	To be supported when trialling unconventional or previously unconsidered approaches.	In our classes, our teachers give us time to really explore and understand new ideas.	Beghetto (2009)
Synthesis	To connect ideas to develop new understandings or approaches.	In our classes, we compare new ideas with what we already know.	Shing and Brod (2016)
Curiosity	A desire to explore, examine and understand how things are and how things work.	In our classes, we get to explore ideas that interest us.	Ostroff (2016)
Autonomy	Providing freedom to students in deciding what work to do and/or how to do it.	I feel that my teachers provide me with choices and options.	Amabile (2018); Hennessey (2010)

assessing such processes, including creative self-efficacy self-reports as indices of creative thinking strategies (see Table 2.1 of Amabile & Mueller, 2008). Parallel with the use of academic self-efficacy self-reports to index domain-relevant skills, self-reports of creative self-efficacy (CSE), “the belief one has the ability to produce creative outcomes” (Tierney & Farmer, 2002, p.1138), can index a student's confidence in bringing such processes to bear. However, research linking CSE with other constructs has typically involved adult participants (for a meta-analysis, see Karwowski & Lebuda, 2016) and therefore some items (e.g., “Compared with my friends, I am distinguished by my imagination and ingenuity”; Karwowski, 2012) may present comprehension challenges to younger students, including elementary school children who have been part of this study's broader program of research. Hence, the present study developed and tested a novel CSE measure for school students.

2.2. Control variables

The survey used for this study contained information on a variety of control variables. Including control variables such as sociodemographic factors in structural models acts to account for variance explained by these factors, thus providing stronger grounds for interpretations of findings (Martin, 2011). In the present study, prior research does not provide particularly clear foundations for hypotheses regarding age and gender, but nonetheless, their inclusion as control variables can be considered “good practice”. In contrast, there are stronger grounds for incorporating non-English speaking background and Aboriginal/Torres Strait Islander as control variables: van Dijk et al. (2019) review a substantial body of research linking children's creativity with bilingualism and experience with multiple cultures. Theorizing around the intra-individual components of the componential model recognizes the role of personality factors in explaining variation (see Fig. 4.1 of Amabile, 2018). Two broad personality factors are particularly germane. *Openness to experience*, representing capacity for imagination alongside artistic and intellectual curiosity (Oleynick et al., 2017), has long been linked with measures of creativity such as creative thinking, achievement, and choice of a creative profession; in the context of the present study, Karwowski and Lebuda's (2016) meta-analysis identified a substantial average correlation ($r = 0.69$) between openness to experience and creative self-efficacy. In contrast, *Conscientiousness*, encompassing goal orientation, carefulness, planning, and self-discipline as key facets, has not been so explicitly linked with creativity, but its role as a control variable in the present study can be justified since high school students' self-reports of conscientiousness have been clearly linked to their academic motivation, including academic self-efficacy (Ginns et al., 2018), and Karwowski and Lebuda's (2016) meta-analysis identified a moderate average correlation ($r = 0.31$) between conscientiousness and creative self-efficacy.

2.3. Aims of the present study

The present study has the following aims, reflected in Fig. 1. First, drawing on scholarship on creative experiences in school settings, it seeks to expand the scope of student experience measures that might reflect this key element of the componential model. Second, it seeks to test direct relations between students' experiences of the school-based social environment and their intrinsic versus extrinsic motivation for school, as well as between these experiences and academic and creative self-efficacy. Third, it seeks to test the extent to which relations between social environment perceptions and academic and creative self-efficacy are mediated by intrinsic versus extrinsic motivation, as predicted by the componential model. Lastly, the study was conducted to investigate the above relations over and above a range of additional sociodemographic and personological covariates.

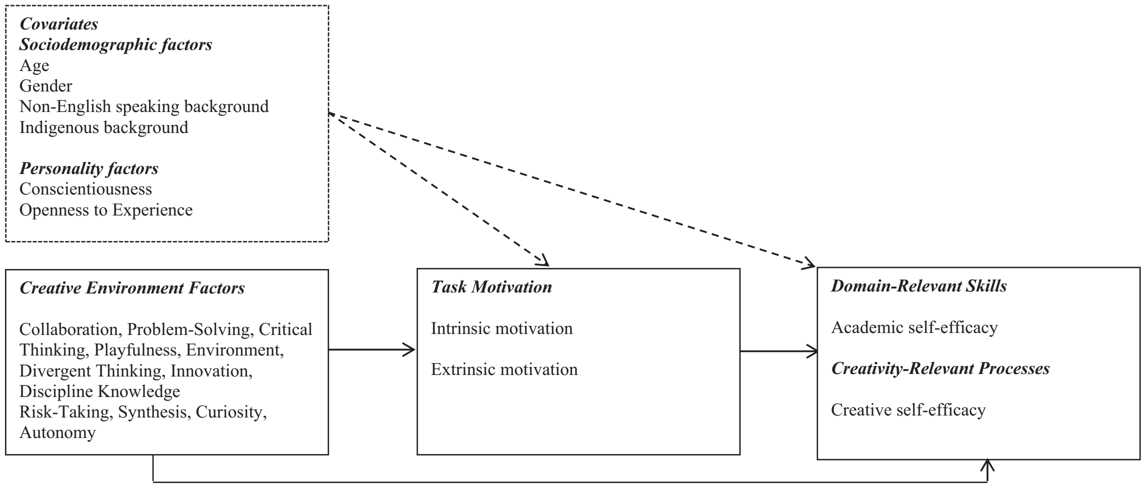

Fig. 1. Hypothesised relations among variables. Note: Bolded single-headed arrows represent substantive path coefficients; dashed lines represent covariate parameters.

3. Method

3.1. Participants

Participants consisted of 2538 students in junior high school, i.e., Grade 7 (50.7%) and Grade 9 (49.3%), from 13 Australian high schools. Schools were mixed ability comprehensive schools, although typically higher in socio-economic status than the Australian national average (mean = 1000; SD = 100) based on schools' Index of Community Socio-Educational Advantage (ACARA, n.d.): mean = 1128.62, SD = 59.42. ICSEA is an aggregate measure of the socio-educational background of students, comprising parental educational levels and occupations for students in a school, as well as geographical location (a potential source of disadvantage), and proportion of Indigenous students. Due to sampling several single-gender schools, 68.7% of the respondents were male. Respondents' mean age was 13.47 (SD = 1.13) years. A total of 20.3% of the sample was from a non-English speaking background, and 2.4% of students were Indigenous Australians.

3.2. Materials and procedure

Students completed the survey during normal classes, supervised by their teachers and a research assistant. Students completed the survey individually on tablets or laptop computers using the Qualtrics survey system, and were invited to ask questions if any aspects of the survey procedure required clarification. The study was approved by the University of Sydney human research ethics committee (Protocol no. 2017/943) and the schools' principals. The survey began with a set of measures probing students' demographics (described below), followed by key self-reported variables of interest. A full list of scales and items used in the present study, along with standardized factor loadings, is provided in "Supporting Information".

Covariate factors were as follows. *Sociodemographic factors* consisted of *age* in years, *gender* (female/male), ethnicity (non-English speaking background, NESB; yes/no), and Indigenous (Aboriginal or Torres Strait Islander) background (yes/no). "Big Five" personality factors – Conscientiousness (omega = 0.77) and Openness to Experience (omega = 0.80) – were assessed using eight items per factor from John and Srivastava's (1999) BFI-46-A instrument for children. Participants rated the extent to which statements were accurate descriptions of themselves, using a 1 (strongly disagree) to 5 (strongly agree) Likert scale.

The first of the substantive elements of the model, representing "social environment", was measured through the "Creative Classrooms Index" (CCI) student experience survey. Students were asked about their perceptions of their classroom experience using 44 items (4 items per sub-scale) beginning with the stem, "In our classes…", and 6 items measuring teacher autonomy support using items developed by Jang et al. (2012). Students responded using a 5-point Likert scale marked 1 = never or only rarely true of the subjects I study, 2 = sometimes true of the subjects I study, 3 = true about half the time, 4 = frequently true of the subjects I study, and 5 = always or almost always true of the subjects I study (omega = 0.97).

The second substantive element of the model, "Task Motivation", was measured using eight items from Gnambs and Hanfstingl's (2014) measure of academic motivation for adolescents. Using a 1 (strongly disagree) to 5 (strongly agree) Likert scale, students described the extent to which they worked on classwork because of intrinsic motivation reasons, e.g. "because it's fun" (omega = 0.84), or extrinsic motivation reasons, e.g. "because otherwise I would get into trouble at home" (omega = 0.70).

The third substantive element of the model, "Domain-relevant skills", was measured using five items based on Bandura's (2001) measure of academic achievement self-efficacy. Students were asked to rate their degree of confidence in a range of academic subject areas (e.g., language arts, mathematics, science) using a Likert scale ranging from 1 (cannot do at all) through 3 (moderately can do) to 5 (highly certain can do) (omega = 0.75).

The fourth substantive element of the model, "Creativity-relevant processes", was based on creative self-efficacy, measured by eight items adapted from Abbott's (2010) creative self-efficacy measure for adults, e.g., "I can imagine brand new ideas" (omega = 0.88).

3.3. Statistical analyses

Analyses consisted of an initial confirmatory factor analysis (CFA), followed by structural equation modeling using M*plus* (Muthén & Muthén, 1998–2010), based on the robust maximum likelihood estimator. Analyses used the 'cluster' command under the 'complex' method in M*plus* to account for the nesting of students within the 13 high schools. This adjusts standard errors for all parameter estimates, reducing bias in tests of statistical significance that might result from clustering effects. Model fit was evaluated using the comparative fit index (CFI), the root mean square error of approximation (RMSEA), and the standardized root mean square residual (SRMR). CFI values range from 0 to 1.00, with values equal to or >0.90 and 0.95, respectively, indicating acceptable and close fit to the data (McDonald & Marsh, 1990). Jöreskog and Sörbom (1993) contended RMSEA values equal to or below 0.05 and 0.08, respectively, constitute close and acceptable levels of fit. In their review of a range of fit indices including the CFI and RMSEA, Marsh et al. (2005) note the CFI contains no penalty for a lack of parsimony; thus, improved fit may be possible with the introduction of additional parameters, but such improvements may merely reflect capitalization on chance. By comparison the RMSEA contains penalties for a lack of parsimony. Values of overall χ^2 and the associated p value for this test are reported but not interpreted as indices of model fit, due to the long-recognized sensitivity of this test to large sample sizes (Marsh, 2007). For the SRMR, Kline (2016) suggests values >0.10 may indicate poor fit. Covariances between error terms of negatively valenced items in the Conscientiousness scale were fitted based on a long-standing recognition of this source of model misfit in personality research (Ginns et al., 2014). Internal consistency of scales was indexed by McDonald's (1999) omega.

Interpretation of results considers explained variance in task motivation, domain-relevant skills, and creativity-relevant processes, as well as magnitude of standardized beta coefficients. Follow-up analyses of indirect effects, testing the extent to which relations between control variables and social environment to academic and creative self-efficacy were carried through intrinsic and extrinsic motivation variables, were also conducted using M*plus*. Keith (2006) proposed the following educational research benchmarks for direct effects in the form of beta coefficients: <0.05 is considered too small to be meaningful, above 0.05 as small but meaningful, above 0.10 as moderate, and above 0.25 to be large. Interpretation of results below focuses on beta coefficients that are educationally meaningful (i.e., $\beta \geq |0.05|$). For indirect effects, Kenny's (2018) definition of an indirect effect as the product of two effects is used; based on Keith's benchmarks above, educationally meaningful indirect effects above 0.003 are considered small, above 0.01 as moderate, and above 0.06 as large.

4. Results

The dimensionality of the variables under analysis was tested using confirmatory factor analysis. Where single item indicators (e.g., age, gender, non-English-speaking background, Indigenous background) were used, the loadings of these indicators were fixed at one and the residuals at zero to allow the estimation of a correlation matrix between observed and latent variables. A twenty-three-factor model, in which the 12 creative environment factors given in Table 1 loaded on a higher order "creative classrooms" factor, had an acceptable fit to the data, $\chi^2(3935) = 13{,}319.64$, $p < 0.001$, CFI = 0.91, RMSEA = 0.031 (90% CI 0.030–0.031), SRMR = 0.042. Descriptive statistics and a latent factor correlation matrix are given in Table 2.[1]

A structural model specifying direct and indirect relations between control variables, social environment, task motivation, academic self-efficacy, and creative self-efficacy was then fitted to the data. This model had acceptable fit to the data, $\chi^2(3936) = 13{,}318.54$, $p < 0.001$, CFI = 0.91, RMSEA = 0.031 (90% CI 0.030–0.031), SRMR = 0.042. Table 3 below provides the standardized beta (β) coefficients representing direct and indirect relations between variables under analysis. Statistically significant proportions of variance were accounted for in the Task Motivation variables (intrinsic motivation: $R^2 = 52\%$; extrinsic motivation: $R^2 = 07\%$), academic self-efficacy ($R^2 = 55\%$), and creative self-efficacy ($R^2 = 53\%$), indicating the overall model included a range of salient predictors.

Focusing first on direct and indirect paths in the substantive part of the componential model: student experiences of the social environment had a large association with intrinsic motivation (β = 0.33) but not extrinsic motivation (β = −0.07), did not predict self-reports of academic self-efficacy (β = 0.04), but did predict creative self-efficacy to a moderate extent (β = 0.16). Student reports of intrinsic motivation had a strong association with academic self-efficacy (β = 0.38) and a moderate association with creative self-efficacy (β = 0.21), whereas extrinsic motivation only predicted academic self-efficacy to a small to moderate extent (β = 0.09). Indirect effects of social environment via intrinsic motivation were large for both academic self-efficacy (β = 0.13) and creative self-efficacy (β = 0.07), whereas indirect paths via extrinsic motivation were small and non-significant. Follow-up analyses using model comparisons confirmed that a structural model with paths from intrinsic and extrinsic motivation to academic self-efficacy constrained to equality had worse fit to the data, $\Delta\chi^2(1) = 44.06$, $p < 0.001$. Likewise, a structural model with paths from intrinsic and extrinsic motivation to creative self-efficacy constrained to equality had worse fit to the data, $\Delta\chi^2(1) = 20.87$, $p < 0.001$.

Of the control variables, the personality variables were the most salient sources of direct and indirect paths. Openness to experience had a moderate to large association with intrinsic motivation (β = 0.22) and a moderate association with extrinsic motivation (β = 0.12), a moderate association with academic self-efficacy (β = 0.15), and a very large association with creative self-efficacy (β = 0.45). The indirect path to academic self-efficacy via intrinsic motivation was large (β = 0.08), while the indirect path via extrinsic motivation was moderate (β = 0.01). The indirect path to creative self-efficacy via intrinsic motivation was moderate to large (β = 0.05), while the indirect path via extrinsic motivation was very small and not statistically reliable (β = 0.00). Student self-reports of conscientiousness had a large association with intrinsic motivation (β = 0.37) and a moderate to large association with extrinsic motivation (β = 0.19), a large association with academic self-efficacy (β = 0.27), and a small to moderate association with creative self-efficacy (β = 0.08). The indirect path to academic self-efficacy via intrinsic motivation was large (β = 0.14), while the indirect path via extrinsic motivation was moderate (β = 0.02). The indirect path to creative self-efficacy via intrinsic motivation was large (β = 0.08), while the indirect path via extrinsic motivation was small and not statistically reliable (β = 0.01).

Direct and indirect paths emanating from the remaining control variables were largely small and not statistically significant, with the following exceptions. Age had mixed direct effects, with a small (β = −0.07) negative association with academic self-efficacy but a small positive effect (β = 0.06) on creative self-efficacy, and gender had a small (β = 0.07) positive association with academic self-efficacy and a small positive effect (β = 0.05) on creative self-efficacy, favoring male students.

5. Discussion

5.1. Theoretical implications

Drawing on Amabile's (2018) componential model, the present study tested direct and indirect paths between student perceptions of creative classroom environments, task motivation, and academic and creative self-efficacy. These paths were estimated while controlling for a range of additional sociodemographic and personological factors, in order to support stringent tests of the substantive paths in the model. Overall, the fit of the structural model tested here supports previous theorizing. In particular, while student perceptions of the social environment was a significant predictor of creative self-efficacy through a direct path, this association was also mediated by intrinsic motivation; moreover, the relationship of social environment with academic self-efficacy was also

[1] We tested an alternative CFA model without the higher order factor which had slightly better fit than the model with the higher order factor: $\chi^2(3771) = 12{,}275.98$, $p < .001$, CFI = 0.92, RMSEA = 0.030 (90% CI 0.029–0.030), SRMR = 0.040. However, the structural model without a higher order social environment factor would not converge, even when iterations were increased to very high levels (10,000). Inspecting the latent correlation matrix for the 12 social environment scales, we found these inter-correlations ranged from 0.79 to 0.99. In a structural model, correlations of this magnitude pose serious problems due to multicollinearity (Marsh et al., 2004; Pedhazur & Schmelkin, 1991), and are the likely source of lack of convergence.

Table 2
Correlations between and descriptive statistics for covariates, social environment, intrinsic and extrinsic motivation, academic self-efficacy, and creative self-efficacy.

	AGE	GEN	ATSI	NESB	CONS	OPEN	ENVR	INTR	EXTR	ACSE	CRSE
AGE	1										
GEN	0.09***	1									
ATSI	0.00		1								
NESB	0.06**	−0.03	−0.07**	1							
CONS	−0.01	0.00	0.05*		1						
OPEN	−0.04	0.05*	0.03	0.02	0.52***	1					
ENVR	−0.09***	0.12***	0.01	−0.01	0.39***	0.28***	1				
INTR	−0.07***	0.02	0.02	0.04	0.62***	0.51***	0.53***	1			
EXTR	0.02	−0.02	−0.01	0.03	0.22***	0.22***	0.04	0.12**	1		
ACSE	−0.09***	0.08**	0.06*	0.07**	0.62***	0.52***	0.40***	0.66***	0.23***	1	
CRSE	0.02	0.10***	0.03	0.01	0.52***	0.65***	0.43***	0.57***	0.17***	0.63***	1
M	13.47	1.69	1.98	1.20	3.46	3.72	3.25	3.15	3.69	3.71	3.63
SD	1.13	0.46	0.15	0.40	0.69	0.72	0.74	0.92	0.83	0.75	0.74
Omega	n/a	n/a	n/a	n/a	0.77	0.80	0.97	0.84	0.70	0.75	0.88

Note: AGE = Age, GEN = Gender, ATSI = Aboriginal/Torres Strait Islander, NESB = Non-English Speaking Background, CONS = Conscientiousness, OPEN = Openness to Experience, ENVR = Social Environment, INTR = Intrinsic Regulation, EXTR = Extrinsic Regulation, ACSE = Academic Self-Efficacy, CRSE = Creative Self-Efficacy.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

Table 3
Standardized beta coefficients.

Predictors	Social environment – direct effects	Task motivation - direct effects		Academic self-efficacy			Creative self-efficacy		
		INTR	EXTR	Direct	Indirect via INTR	Indirect via EXTR	Direct	Indirect via INTR	Indirect via EXTR
AGE	−0.10**	−0.04**	0.02	−0.07*	−0.03**	0.00	0.06**	−0.01**	0.00
GENDER	0.12**	−0.03	−0.02	0.07***	0.01	0.00	0.05*	0.00	0.00
ATSI	−0.01	−0.01	−0.02	0.04	0.00	0.00	0.01	0.00	0.00
NESB	−0.01	0.04#	0.03	0.05**	0.02	0.00	−0.01	0.01	0.00
CONS	0.35***	0.37***	0.19***	0.27***	0.19***	0.02**	0.08**	0.10***	0.01
OPEN	0.08	0.22***	0.12***	0.15***	0.09***	0.01**	0.45***	0.05***	0.00
ENVR	–	0.33***	−0.07#	0.04	0.13***	−0.01	0.16***	0.07***	0.00
INTR	–	–	–	0.38***	–	–	0.21***	–	–
EXTR	–	–	–	0.09***	–	–	0.03	–	–

Note. AGE = Age, GEN = Gender, ATSI = Aboriginal/Torres Strait Islander, NESB = Non-English Speaking Background, CONS = Conscientiousness, OPEN = Openness to Experience, ENVR = Social Environment, INTR = Intrinsic Motivation, EXTR = Extrinsic Motivation.
\# $0.06 < p < 0.05$.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

mediated by intrinsic motivation.

As a social-psychological model of creativity, the componential model foregrounds the role of the social environment in understanding creativity-related processes and outcomes. Drawing on elements of the componential model, the present study established that students' perceptions of a broad range of creativity-supportive classroom experiences was directly related to intrinsic (but not extrinsic) motivation, and to creative self-efficacy, both directly and indirectly via intrinsic motivation. In contrast, no relations with extrinsic motivation were substantial as well as statistically significant. Also central to Amabile's (2018) model is the role of task motivation, and specifically intrinsic motivation, in fostering creativity. The present study juxtaposed the role of both intrinsic and extrinsic motivation for schoolwork in predicting academic and creative self-efficacy. Across the complex of direct and indirect paths tested, the difference in paths emanating from intrinsic and extrinsic motivation was marked: direct paths from intrinsic motivation predicting academic and creative self-efficacy were clearly more substantial than those from extrinsic motivation. Structural models in which the paths from intrinsic and extrinsic motivation to academic and creative self-efficacy were constrained to be equal showed poorer fit to the data compared to models where these paths were estimated freely. Likewise, of the indirect paths tested through to academic and creative self-efficacy, those emanating from intrinsic motivation were again more substantial. Taken together, these results provide substantial support for the Intrinsic Motivation Hypothesis of Creativity (Amabile, 1983).

Another contribution of the present study is the consideration of a range of control variables. Demographic variables were limited in their direct and indirect associations with academic and creative self-efficacy, compared to the measures of Big Five Openness to Experience and Conscientiousness. Interestingly, indirect paths from Conscientiousness through intrinsic motivation to both academic and creative self-efficacy were somewhat larger than indirect paths from Openness to Experience. These results confirm the well-established role of Openness to Experience in understanding creativity (Oleynick et al., 2017), but also extend the role of Conscientiousness in understanding school-based learning processes and outcomes (cf. Ginns et al., 2014) through to the domain of creativity.

5.2. Practical implications

Several implications for educators flow from the present study. First, the study demonstrates students' perceptions of creativity support can be measured reliably and validly, using a survey instrument that captures a larger number of facets of creativity support than has been the case to date. The breadth of this measure provides a greater scope to educators than previously available and may support teachers and curriculum designers in considering a range of ways in which creativity can be facilitated in schools, rather than focus on only one or two "pieces of the puzzle". School leaders may employ these factors to develop school environments that are conducive to the development of creative education. For teachers, the development of creative pedagogies based on the components of the model could also generate school environments conducive to high quality creativity learning. For policy makers, these factors could be embedded into syllabus and curriculum to ensure that each school is enabled to implement high quality creativity education.

To achieve these learning environments that truly promote student creativity as one of several potential "21st Century skills", it is likely that schools will need to transform the curriculum (cf. Jefferson & Anderson, 2017) rather than continue with traditional curriculum models, or aim to build student creativity only with "packaged" activities. Curriculum models that align learning objectives, teaching and learning activities, and assessment tasks fostering creativity will be most likely to reach curricular goals (for examples, see Beghetto et al., 2014; Jefferson & Anderson, 2017; McNair, 2017; White, 2019). However, such models may fail if they do not simultaneously develop foundational knowledge which can be used in creative ways (Sweller, 2009). In his Load Reduction Instruction (LRI) framework, Martin (2016; Martin & Evans, 2018) lays out an instructional approach that manages novices' cognitive load in the initial stages of learning, transitioning to guided independent learning as fluency and automaticity develops. Given that relatively independent, project-based work is often considered a desirable element of a curriculum that fosters creativity (e.g., McNair, 2017), the perspective of load reduction provides a useful touchstone for developing student readiness for such work.

Beyond the clear role of the social environment for supporting creativity, the present study's support for the role of intrinsic motivation implies teachers must carefully consider how to it might be fostered. Reviewing a range of theoretical perspectives, Brophy (1998) identifies a substantial number of educational practices that stand to support intrinsic motivation for learning, with a particular emphasis on supporting students' self-determination, and needs for autonomy, competence, and relatedness (cf. Niemiec & Ryan, 2009). Hennessey's (2010) review of educational research as it relates to intrinsic motivation and creativity notes that school environments and curricula will be shaped to a substantial extent by external policies. Such policies may support practices that undermine intrinsic motivation such as "task-contingent rewards, competitive elements, and controlling systems of evaluation" (Hennessey, 2010, p.340). Under such circumstances, "immunization" against the effects of extrinsic rewards may be crucial in sustaining students' intrinsic motivation (Hennessey et al., 1989; Hennessey & Zbikowski, 1993).

5.3. Limitations and future directions

The scope of the present study includes several limitations that suggest productive directions for future research. In seeking to understand relations between social, motivational, and self-efficacy constructs informed by the componential model in school settings, the present study did not include measures of problem-solving processes or outcomes (see Fig. A of Amabile, 2018, p.113). In educational settings, students' broad self-efficacy reports are often considered important measures in themselves (Kember & Ginns, 2012; Pampaka et al., 2011), providing reasonable proxies for development of students' capabilities and confidence levels, as well as predicting educational aspirations (Ginns et al., 2018). Nonetheless, future studies would benefit from inclusion of objective measures of domain-relevant skills, such as grade point average from school records, or standardized academic assessments such as NAPLAN (ACARA, 2011) in the Australian context, alongside creativity-relevant processes such as divergent production (Kaufman et al., 2011) and convergent thinking (Lee et al., 2014). Given the wide range of teaching and learning activities and outcomes taking place in schools, as well as curriculum variation across year grades and schools, it is an open question as to what process and outcome measures related to creative problem-solving would be fitting for a relatively "wide focus" investigation such as the present study; the OECD's (2019b) PISA Creative Thinking framework is a step in this direction. One possibility for future research is to position investigations in particular subject areas (e.g., language arts, science), so that student self-reports such as Diedrich et al.'s (2018) Inventory of Creative Activities and Achievements can be linked with creative processes and achievements on relatively standardized measures (e.g., Hu & Adey, 2002).

The cross-sectional nature of the present study also raises questions regarding causal pathways. Nonetheless, cross-sectional studies might yield prescriptive possibilities and inferences when "findings are consistent with theory, employ appropriate covariates, are based on large and representative samples, reflect strong measurement properties, and yield educationally meaningful effect sizes" (Martin, 2011, p.241), all of which hold for the present study. Future research would benefit from the use of longitudinal designs, allowing for causal paths to be estimated controlling for prior variance, as well as feedback loops such as the path in Amabile's (2018) model from outcomes to task motivation. A larger sample of schools (at least 100; see Hox & Maas, 2001) would also support estimation of multi-level structural models, allowing cluster (e.g., school or classroom) and student effects to be disentangled (Marsh et al., 2009; Martin et al., 2020). Alternatively, a subject-specific (e.g., science, language arts) version of the Creative Classrooms Index might be administered across a large number of classrooms to test relations between student experience of creativity and learning processes and outcomes at the classroom level. Future research might also use the various measures introduced in this study to measure the impact of classroom-based curricular innovations to nurture student creativity (Jefferson & Anderson, 2017; Beghetto et al., 2014), including specific programs such as Genius Hour (McNair, 2017) and Thinking Tools (Treffinger & Nassab, 2000). While the present study provides a starting point for instrumentation in future studies, continuing refinement of scales and items is warranted to reflect the specific features of such settings.

In conclusion, the present study drew on a seminal social-psychological model of creativity to test pathways between high school students' perceptions of creativity supports in their classrooms, their motivations for schoolwork, and their academic and creative self-efficacy. Providing evidence for both direct and indirect paths between these variables, the study confirms key elements of the componential model as it applies to educational settings.

Acknowledgments

This work was supported by The Chartwell Trust, New Zealand.

Appendix A. Supplementary data: Scales and items

Supplementary data to this article can be found online at https://doi.org/10.1016/j.lindif.2021.102057.

References

Abbott, D. H. (2010). *Constructing a creative self-efficacy inventory: A mixed methods inquiry* [Unpublished doctoral dissertation]. The University of Nebraska-Lincoln.
Amabile, T. M. (1979). Effects of external evaluation on artistic creativity. *Journal of Personality and Social Psychology, 37*(2), 221–233. https://doi.org/10.1037/0022-3514.37.2.221.
Amabile, T. M. (1982). Children's artistic creativity: Detrimental effects of competition in a field setting. *Personality and Social Psychology Bulletin, 8*(3), 573–578. https://doi.org/10.1177/0146167282083027.
Amabile, T. M. (1983). *The social psychology of creativity*. New York, NY: Springer-Verlag.
Amabile, T. M. (2018). *Creativity in context: Update to the social psychology of creativity*. New York, NY: Routledge.
Amabile, T. M., Conti, R., Coon, H., Lazenby, J., & Herron, M. (1996). Assessing the work environment for creativity. *Academy of Management Journal, 39*(5), 1154–1184.

Amabile, T. M., DeJong, W., & Lepper, M. R. (1976). Effects of externally imposed deadlines on subsequent intrinsic motivation. *Journal of Personality and Social Psychology, 34*(1), 92–98. https://doi.org/10.1037/0022-3514.34.1.92.
Amabile, T. M., & Gryskiewicz, N. D. (1989). The creative environment scales: Work environment inventory. *Creativity Research Journal, 2*(4), 231–253. https://doi.org/10.1080/10400418909534321.
Amabile, T. M., Hill, K. G., Hennessey, B. A., & Tighe, E. M. (1994). The Work Preference Inventory: Assessing intrinsic and extrinsic motivational orientations. *Journal of Personality and Social Psychology, 66*(5), 950–967. https://doi.org/10.1037/0022-3514.66.5.950.
Amabile, T. M., & Mueller, J. S. (2008). Studying creativity, its processes, and its antecedents: An exploration of the componential theory of creativity. In J. Zhou, & C. E. Shalley (Eds.), *Handbook of organizational creativity* (pp. 31–62). Lawrence Erlbaum Associates.
Amabile, T. M., & Pillemer, J. (2012). Perspectives on the social psychology of creativity. *The Journal of Creative Behavior, 46*(1), 3–15. https://doi.org/10.1002/jocb.001.
Anderson, R. C., Pitts, C., & Smolkowski, K. (2017). Creative ideation meets relational support: Measuring links between these factors in early adolescence. *Creativity Research Journal, 29*(3), 244–256. https://doi.org/10.1080/10400419.2017.1360057.
Australian Curriculum, Assessment and Reporting Authority (ACARA). (2011). NAPLAN: National assessment program. Retrieved from http://www.nap.edu.au/naplan.html.
Australian Curriculum, Assessment and Reporting Authority (ACARA) (n.d.). Making a fair comparison - ICSEA. Retrieved from https://www.myschool.edu.au/more-information/information-for-parents/making-a-fair-comparison/.
Bandura, A. (2001). *Guide for constructing self-efficacy scales (monograph)*. Stanford, CA: Stanford University.
Beghetto, R. A. (2009). Correlates of intellectual risk taking in elementary school science. *Journal of Research in Science Teaching, 46*(2), 210–223. https://doi.org/10.1002/tea.20270.
Beghetto, R. A. (2019). The role of humor in teaching for creativity. In S. R. Luria, J. Baer, & J. C. Kaufman (Eds.), *Creativity and humor: Explorations in creativity research* (pp. 143–155). Academic Press.
Beghetto, R. A., Kaufman, J. C., & Baer, J. (2014). *Teaching for creativity in the common core classroom.* New York, NY: Teachers College Press.
Beyers, R. N. (2010). Nurturing creativity and innovation through FabKids: A case study. *Journal of Science Education and Technology, 19*(5), 447–455. https://doi.org/10.1007/s10956-010-9212-0.
Brophy, J. (1998). *Motivating students to learn.* Boston, M: McGraw-Hill.
Chang, S. H., Wang, C. L., & Lee, J. C. (2016). Do award-winning experiences benefit students' creative self-efficacy and creativity? The moderated mediation effects of perceived school support for creativity. *Learning and Individual Differences, 51*, 291–298. https://doi.org/10.1016/j.lindif.2016.09.011.
Choi, J. N. (2004). Individual and contextual predictors of creative performance: The mediating role of psychological processes. *Creativity Research Journal, 16*(2–3), 187–199. https://doi.org/10.1080/10400419.2004.9651452.
Csikszentmihalyi, M. (1988). Society, culture, and person: A systems view of creativity. In R. J. Sternberg, & J. E. Davidson (Eds.), *Conceptions of giftedness* (pp. 325–339). New York, NY: Cambridge University Press.
Davies, D., Jindal-Snape, D., Collier, C., Digby, R., Hay, P., & Howe, A. (2013). Creative learning environments in education—A systematic literature review. *Thinking Skills and Creativity, 8*, 80–91. https://doi.org/10.1016/j.tsc.2012.07.004.
Deci, E. L. (1971). Effects of externally mediated rewards on intrinsic motivation. *Journal of Personality and Social Psychology, 18*(1), 105–115. https://doi.org/10.1037/h0030644.
Deci, E. L. (1972). Intrinsic motivation, extrinsic reinforcement, and inequity. *Journal of Personality and Social Psychology, 22*(1), 113–120. https://doi.org/10.1037/h0032355.
Diedrich, J., Jauk, E., Silvia, P. J., Gredlein, J. M., Neubauer, A. C., & Benedek, M. (2018). Assessment of real-life creativity: The Inventory of Creative Activities and Achievements (ICAA). *Psychology of Aesthetics, Creativity, and the Arts, 12*(3), 304–316. https://doi.org/10.1037/aca0000137.
Dorman, J. P. (2003). Cross-national validation of the What Is Happening In this Class? (WIHIC) questionnaire using confirmatory factor analysis. *Learning Environments Research, 6*(3), 231–245. https://doi.org/10.1023/A:1027355123577.
Dwyer, C. P., Hogan, M. J., & Stewart, I. (2014). An integrated critical thinking framework for the 21st century. *Thinking Skills and Creativity, 12*, 43–52. https://doi.org/10.1016/j.tsc.2013.12.004.
Gignac, G. E., & Szodorai, E. T. (2016). Effect size guidelines for individual differences researchers. *Personality and Individual Differences, 102*, 74–78. https://doi.org/10.1016/j.paid.2016.06.069.
Ginns, P., Martin, A. J., Liem, G. A. D., & Papworth, B. (2014). Structural and concurrent validity of the International English Big-Five Mini-Markers in an adolescent sample: Exploring analytic approaches and implications for personality assessment. *Journal of Research in Personality, 53*, 182–192. https://doi.org/10.1016/j.jrp.2014.10.001.
Ginns, P., Martin, A. J., & Papworth, B. (2018). Student learning in Australian high schools: Contrasting personological and contextual variables in a longitudinal structural model. *Learning and Individual Differences, 64*, 83–93. https://doi.org/10.1016/j.lindif.2018.03.007.
Gnambs, T., & Hanfstingl, B. (2014). A differential item functioning analysis of the German Academic Self-Regulation Questionnaire for Adolescents. *European Journal of Psychological Assessment, 30*(4), 251–260. https://doi.org/10.1027/1015-5759/a000185.
Harris, A. (2016). *Creativity and education.* London: Palgrave Macmillan.
Hennessey, B. A. (2010). Intrinsic motivation and creativity in the classroom: We come full circle? In R. A. Beghetto, & J. C. Kaufman (Eds.), *Nurturing creativity in the classroom.* Cambridge: Cambridge University Press.
Hennessey, B. A. (2015). Creative behavior, motivation, environment and culture: The building of a systems model. *The Journal of Creative Behavior, 49*(3), 194–210. https://doi.org/10.1002/jocb.97.
Hennessey, B. A., Amabile, T. M., & Martinage, M. (1989). Immunizing children against the negative effects of reward. *Contemporary Educational Psychology, 14*(3), 212–227. https://doi.org/10.1016/0361-476X(89)90011-8.
Hennessey, B. A., & Zbikowski, S. M. (1993). Immunizing children against the negative effects of reward: A further examination of intrinsic motivation training techniques. *Creativity Research Journal, 6*(3), 297–307. https://doi.org/10.1080/10400419309534485.
Hill, K. G. (1991). *An ecological approach to creativity and motivation: Trait and environment influences in the college classroom* (Unpublished doctoral dissertation). Brandeis University.
Hox, J. J., & Maas, C. J. (2001). The accuracy of multilevel structural equation modeling with pseudobalanced groups and small samples. *Structural Equation Modeling, 8*(2), 157–174. https://doi.org/10.1207/S15328007SEM0802_1.
Hu, W., & Adey, P. (2002). A scientific creativity test for secondary school students. *International Journal of Science Education, 24*(4), 389–403. https://doi.org/10.1080/09500690110098912.
Isaksen, S. G. (2007). The Situational Outlook Questionnaire: Assessing the context for change. *Psychological Reports, 100*(2), 455–466. https://doi.org/10.2466/pr0.100.2.455-466.
Jang, H., Kim, E. J., & Reeve, J. (2012). Longitudinal test of self-determination theory's motivation mediation model in a naturally occurring classroom context. *Journal of Educational Psychology, 104*(4), 1175–1188. https://doi.org/10.1037/a0028089.
Jefferson, M., & Anderson, M. (2017). *Transforming schools: Creativity, critical reflection, communication, collaboration.* Bloomsbury.
John, O. P., & Srivastava, S. (1999). The Big Five Trait taxonomy: History, measurement, and theoretical perspectives. In L. A. Pervin, & O. P. John (Eds.), *Handbook of personality: Theory and research* (pp. 102–138). Guilford Press.
Jöreskog, K. G., & Sörbom, D. (1993). *LISREL 8: Structural equation modeling with the SIMPLIS command language*. Chicago, IL: Scientific Software International.
Karwowski, M. (2012). Did curiosity kill the cat? Relationship between trait curiosity, creative self-efficacy and creative personal identity. *Europe's Journal of Psychology, 8*(4), 547–558. https://doi.org/10.5964/ejop.v8i4.513.
Karwowski, M., & Lebuda, I. (2016). The Big Five, the Huge Two, and creative self-beliefs: A meta-analysis. *Psychology of Aesthetics, Creativity, and the Arts, 10*(2), 214–232. https://doi.org/10.1037/aca0000035.
Kaufman, J. C., & Beghetto, R. A. (2009). Beyond big and little: The four c model of creativity. *Review of General Psychology, 13*(1), 1–12. https://doi.org/10.1037/a0013688.
Kaufman, J. C., Kaufman, S. B., & Lichtenberger, E. O. (2011). Finding creative potential on intelligence tests via divergent production. *Canadian Journal of School Psychology, 26*(2), 83–106. https://doi.org/10.1177/0829573511406511.
Keith, T. Z. (2006). *Multiple regression and beyond.* Boston, MA: Pearson Education.
Kember, D., & Ginns, P. (2012). *Evaluating teaching and learning: A practical handbook for colleges, universities and the scholarship of teaching.* Routledge.
Kenny, D. (2018). Effect size of the indirect effect and the computation of power. Retrieved from davidakenny.net/cm/mediate.htm.
Kim, K. H. (2011). The creativity crisis: The decrease in creative thinking scores on the Torrance Tests of Creative Thinking. *Creativity Research Journal, 23*(4), 285–295. https://doi.org/10.1080/10400419.2011.627805.
Kline, R. B. (2016). *Principles and practice of structural equation modeling* (4th ed.). New York: Guilford Press.
Kupers, E., Lehmann-Wermser, A., McPherson, G., & van Geert, P. (2019). Children's creativity: A theoretical framework and systematic review. *Review of Educational Research, 89*(1), 93–124. https://doi.org/10.3102/0034654318815707.
Kyndt, E., Raes, E., Lismont, B., Timmers, F., Cascallar, E., & Dochy, F. (2013). A meta-analysis of the effects of face-to-face cooperative learning. Do recent studies falsify or verify earlier findings? *Educational Research Review, 10*, 133–149. https://doi.org/10.1016/j.edurev.2013.02.002.
Lee, C. S., Huggins, A. C., & Therriault, D. J. (2014). A measure of creativity or intelligence? Examining internal and external structure validity evidence of the Remote Associates Test. *Psychology of Aesthetics, Creativity, and the Arts, 8*(4), 446–460. https://doi.org/10.1037/a0036773.
Lepper, M. R., & Greene, D. (1975). Turning play into work: Effects of adult surveillance and extrinsic rewards on children's intrinsic motivation. *Journal of Personality and Social Psychology, 31*(3), 479–486. https://doi.org/10.1037/h0076484.
Lepper, M. R., Greene, D., & Nisbett, R. E. (1973). Undermining children's intrinsic interest with extrinsic reward: A test of the "overjustification" hypothesis. *Journal of Personality and Social Psychology, 28*(1), 129–137. https://doi.org/10.1037/h0035519.
Marsh, H. W. (2007). Application of confirmatory factor analysis and structural equation modeling in sport and exercise psychology. In G. Tenenbaum, & R. C. Eklund (Eds.), *Handbook of sport psychology* (pp. 774–798). John Wiley & Sons, Inc.
Marsh, H. W., Dowson, M., Pietsch, J., & Walker, R. (2004). Why multicollinearity matters: A reexamination of relations between self-efficacy, self-concept, and achievement. *Journal of Educational Psychology, 96*(3), 518–522. https://doi.org/10.1037/0022-0663.96.3.518.
Marsh, H. W., Hau, K.-T., & Grayson, D. (2005). Goodness of fit evaluation in structural equation modeling. In A. Maydeu-Olivares, & J. McArdle (Eds.), *Contemporary psychometrics. A festschrift for Roderick P. McDonald* (pp. 275–340). Mahwah NJ: Erlbaum.

Marsh, H. W., Lüdtke, O., Robitzsch, A., Trautwein, U., Asparouhov, T., Muthén, B., & Nagengast, B. (2009). Doubly-latent models of school contextual effects: Integrating multilevel and structural equation approaches to control measurement and sampling error. *Multivariate Behavioral Research, 44*(6), 764–802. https://doi.org/10.1080/00273170903333665.

Martin, A. J. (2011). Prescriptive statements and educational practice: What can structural equation modeling (SEM) offer? *Educational Psychology Review, 23*(2), 235–244. https://doi.org/10.1007/s10648-011-9160-0.

Martin, A. J. (2016). *Using load reduction instruction (LRI) to boost motivation and engagement*. Leicester, UK: British Psychological Society.

Martin, A. J., & Evans, P. (2018). Load reduction instruction: Exploring a framework that assesses explicit instruction through to independent learning. *Teaching and Teacher Education, 73*, 203–214. https://doi.org/10.1016/j.tate.2018.03.018.

Martin, A. J., Ginns, P., Burns, E. C., Kennett, R., & Pearson, J. (2020). Load reduction instruction in science and students' science engagement and science achievement. *Journal of Educational Psychology*. https://doi.org/10.1037/edu0000552 (Advance online publication).

McDonald, R. P. (1999). *Test theory: A unified treatment*. Mahwah, NJ: Lawrence Erlbaum.

McDonald, R. P., & Marsh, H. W. (1990). Choosing a multivariate model: Noncentrality and goodness of fit. *Psychological Bulletin, 107*(2), 247–255.

McNair, A. (2017). *Genius hour: Passion projects that ignite innovation and student inquiry*. Waco TX: Prufrock Press.

Multon, K. D., Brown, S. D., & Lent, R. W. (1991). Relation of self-efficacy beliefs to academic outcomes: A meta-analytic investigation. *Journal of Counseling Psychology, 38*(1), 30–38. https://doi.org/10.1037/0022-0167.38.1.30.

Muthén, L. K., & Muthén, B. O. (1998–2010). *Mplus user's guide*. Los Angeles: Muthén & Muthén.

Niemiec, C. P., & Ryan, R. M. (2009). Autonomy, competence, and relatedness in the classroom: Applying self-determination theory to educational practice. *Theory and Research in Education, 7*(2), 133–144. https://doi.org/10.1177/1477878509104318.

OECD. (2019a). Teaching, assessing and learning creative and critical thinking skills in education. Retrieved from https://www.oecd.org/education/ceri/assessingprogressionincreativeandcriticalthinkingskillsineducation.htm.

OECD. (2019b). PISA 2021 creative thinking framework (third draft). Retrieved from https://www.oecd.org/pisa/publications/PISA-2021-creative-thinking-framework.pdf.

Oleynick, V. C., DeYoung, C. G., Hyde, E., Kaufman, S. B., Beaty, R. E., & Silvia, P. J. (2017). Openness/intellect: The core of the creative personality. In G. J. Feist, R. Reiter-Palmon, & J. C. Kaufman (Eds.), *The Cambridge handbook of creativity and personality research* (pp. 9–27). New York, NY, US: Cambridge University Press.

Ostroff, W. L. (2016). *Cultivating curiosity in K-12 classrooms: How to promote and sustain deep learning*. Association for Supervision & Curriculum Development.

Pampaka, M., Kleanthous, I., Hutcheson, G. D., & Wake, G. (2011). Measuring mathematics self-efficacy as a learning outcome. *Research in Mathematics Education, 13*(2), 169–190. https://doi.org/10.1080/14794802.2011.585828.

Pedhazur, E. J., & Schmelkin, L. P. (1991). Measurement, design, and analysis: An integrated approach. *Erlbaum*.

Rhodes, M. (1961). An analysis of creativity. *The Phi Delta Kappan, 42*(7), 305–310. https://www.jstor.org/stable/20342603.

Richardson, M., Abraham, C., & Bond, R. (2012). Psychological correlates of university students' academic performance: A systematic review and meta-analysis. *Psychological Bulletin, 138*(2), 353–387. https://doi.org/10.1037/a0026838.

Shing, Y. L., & Brod, G. (2016). Effects of prior knowledge on memory: Implications for education. *Mind, Brain, and Education, 10*(3), 153–161. https://doi.org/10.1111/mbe.12110.

Sweller, J. (2009). Cognitive bases of human creativity. *Educational Psychology Review, 21*(1), 11–19. https://doi.org/10.1007/s10648-008-9091-6.

Tierney, P., & Farmer, S. M. (2002). Creative self-efficacy: Its potential antecedents and relationship to creative performance. *Academy of Management Journal, 45*(6), 1137–1148. https://doi.org/10.2307/3069429.

Torrance, E. P. (1961). *Guiding creative talent*. Englewood Cliffs, NJ: Prentice-Hall.

Treffinger, D. J., & Nassab, C. A. (2000). *Thinking tools lessons: A collection of lessons for teaching creative & critical thinking*. Prufrock Press.

Treffinger, D. J., Isaksen, S. G., & Dorval, K. B. (1994). Creative problem solving: An overview. In M. A. Runco (Ed.), *Problem finding, problem solving, and creativity*. Hillsdale, NJ: Ablex.

van Dijk, M., Kroesbergen, E. H., Blom, E., & Leseman, P. P. (2019). Bilingualism and creativity: Towards a situated cognition approach. *The Journal of Creative Behavior, 53*(2), 178–188. https://doi.org/10.1002/jocb.238.

Westrick, P. A., Le, H., Robbins, S. B., Radunzel, J. M., & Schmidt, F. L. (2015). College performance and retention: A meta-analysis of the predictive validities of ACT® scores, high school grades, and SES. *Educational Assessment, 20*(1), 23–45. https://doi.org/10.1080/10627197.2015.997614.

White, K. (2019). *Unlocked: Assessment as the key to everyday creativity in the classroom*. Bloomington, IN: Solution Tree Press.