ORIGINAL PAPER

# Whether highly curious students thrive academically depends on perceptions about the school learning environment: A study of Hong Kong adolescents

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Published online: 23 October 2007 © Springer Science+Business Media, LLC 2007

**Abstract** The present study tested whether the perceived academic values of a school moderate whether highly curious students thrive academically. We investigated the interactive effects of curiosity and school quality on academic success for 484 Hong Kong high school students. Chinese versions of the Curiosity and Exploration Inventory, Subjective Happiness Scale, and Rosenberg Self-Esteem scales were administered and shown to have acceptable measurement properties. We obtained Hong Kong Certificate of Education Examination (HKCEE) scores (national achievement tests) from participating schools. Results yielded Trait Curiosity × Perceived School Quality interactions in predicting HKCEE scores and school grades. Adolescents with greater trait curiosity in more challenging schools had the greatest academic success; adolescents with greater trait curiosity in less challenging schools had the least academic success. Findings were not attributable to subjective happiness or self-esteem and alternative models involving these positive attributes were not supported. Results suggest that the benefits of curiosity are activated by student beliefs that the school environment supports their values about growth and learning; these benefits can be disabled by perceived person-environment mismatches.

Portions of this article were presented at the 2004 International Positive Psychology Summit.

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M. Yuen University of Hong Kong, Hong Kong, China **Keywords** Curiosity · Education · Performance · Culture · Well-being · Self-esteem

### Introduction

Being curious and open to a variety of thoughts, perspectives, and ideas facilitates learning and better academic performance (Lent et al. 1994) that cannot be attributed to intellectual ability (e.g., Alberti and Witryol 1994; Reiss and Reiss 2004). The most desirable student outcomes result when there is congruence between the characteristics of a student and the qualities of their social environment. Curious students should prosper in schools that value and cultivate their intense desire to acquire novel and challenging information and experiences. The present research analyzes the interplay between students' curiosity and school environment in the prediction of academic success. The component of school environment under investigation was the perceived availability of intellectual challenge and learning opportunities. The focus was on adolescent students situated in Hong Kong, a collectivist culture with one of the most competitive educational systems in the world.

Nature of curiosity

Feelings of curiosity can be defined as the recognition, pursuit, and intense desire to investigate novel, challenging, or puzzling phenomena (Izard 1977). When people feel curious, they are more attentive, process information at a deeper level, better retain information, and more likely to persist on tasks until goals are met (Ainley et al. 2002; Sansone and Smith 2000; Schiefele 1999). The immediate function of curiosity is to learn, explore, and immerse oneself in initially interesting events. In the longer term, curiosity functions to build knowledge and skills (Rathunde and Csikszentmihalyi 1993; Tracey 2002). Tendencies to feel curious and be exploratory seem well-suited to predict manifest indicators of learning: academic grades and achievement test scores.

The value of fit: curiosity and challenging school environments

There is reason to believe that the quality of school experiences serves as a crucial moderating influence on whether highly curious students thrive academically. Personenvironment fit approaches stipulate that people's adjustment increases when the environment provides the demands and support structure to satisfy specific needs and competencies (Eccles et al. 1993; Kristof 1996; Pervin 1968). People perform best in contexts that are a better fit with their habitual behavior tendencies and the worst in contexts that are counter to these tendencies. From what is known about highly curious students, they should be highly sensitive to environments that value their preference for novelty, intellectual challenge, and growth potential. A few studies have shown that people who are curious and open to new ideas perform better in school and work settings (a) characterized by intellectual challenge and receptivity to new ideas, and (b) providing ample opportunities to develop knowledge and skills (Harms et al. 2006; Wanberg and Banas 2000; Wanberg and Kammeyer-Mueller 2000).

The prior literature provides some support for the potential insufficiency of "main effect" models to understand how people's curiosity operates in larger social systems. School environments supporting students' desires to be autonomous learners are positively related to student motivation (effort, persistence, coping), in turn, facilitating engagement and interest, which directly leads to greater academic success (Skinner et al. 1990). At the other extreme, school environments perceived as threatening or unsupportive can impede natural exploratory behavior. In one study, students high in trait curiosity initiated nearly five times as many classroom questions compared to their less curious peers, but both groups became equally inhibited when teachers were perceived as threatening (Peters 1978).<sup>1</sup>

<sup>1</sup> Much of this literature measures curiosity-related characteristics such as interest, openness to experience, need for cognition, flow, and intrinsic motivation. These variables share a great deal of conceptual overlap and based on how they are measured, are often interchangeable (Kashdan 2004a, b; Kashdan and Silvia, in press; Silvia 2006).

Contextual considerations: examining curiosity and academic success in Hong Kong

In school, the dominant striving is to succeed academically and obtain increasingly greater levels of knowledge. The present study explored the role of curiosity and school perceptions on academic success in Hong Kong adolescents.

As a collectivist culture, the primary values include being a good citizen, and living in accordance with social norms and the expectations of important, significant others (e.g., Hsu 1981); these values can be contrasted with individualism. Collectivist values are ingrained such that a person's self-concept is interdependent with the values of family, friends, community members, and authority figures (Markus and Kitayama 1991). Yet, at the individual level, people in Hong Kong place a tremendous emphasis on academic success. Parents and schools devote extensive resources for children to achieve at high levels, and being a scholar is one of the most valued professions. Students compete for the greatest academic success to get into top secondary schools because there are a finite number of college openings. Unlike national achievement tests in the United States, in Hong Kong, only the top 3-4% of students can obtain grades of A in a subject. This creates a funnel where students are streamlined into different bands as a function of test scores. There are only eight Hong Kong universities and getting in is an efficient path to becoming a highly valued contributor to society.

In this context of collectivist group values and competitive academics at the individual level, the pursuit of academic success cannot be easily divided into the Western distinction of intrinsic and extrinsic motivation. In interviews about academics, 40% of Hong Kong students mention intrinsic interest in their studies as well as extrinsic interest in obtaining a good career to aid themselves and their family (Kember 2000). This dialectic between intrinsic and extrinsic motivation is a common characteristic of people in Asian cultures (Spencer-Rodgers et al. 2004). Based on the social norms of Hong Kong, there may be less variability in academic performance goals and greater variability in students' curiosity and the pursuit of learning for its own intrinsic rewards, with both being important to predicting academic outcomes (Harackiewicz et al. 2002).

To date, only one published study has shown that the benefits of curiosity-related traits on academic success are partially dependent on a good "fit" with the school environment (Harms et al. 2006). Harms and colleagues examined students at an elite "high-cultured" American university and thus, generalizability is limited. In contrast to other cultures, the influence of curiosity on academic outcomes was expected to be more contingent on

environmental factors in cultures such as China with strong collectivist values. Preliminary data show that among Chinese students, curiosity is positively related to school achievement (Wavo 2004) and high curiosity differentiates over- and under-achieving students (Lau and Chan 2001). However, these studies were limited to examinations of "main effect" models. In a collectivist culture, curiosity might only lead to academic success when the school appears to value and invest in students' pursuit of novelty, challenge, and personal growth; schools failing to endorse these values might undermine the effects of curiosity on academic achievement.

### Overview of present study

Highly curious people derive more immediate and lasting psychological and intellectual benefits compared to their less curious peers (e.g., Kashdan and Steger 2007; Raine et al. 2002). But there may be boundary conditions to these relations. This includes how people evaluate the social systems they are embedded in, which can impact exploratory behavior, competence beliefs, learning, and achievement. We examined whether perceptions of school academic challenge and values, moderate the influence of curiosity on academic success. Highly curious students were expected to show the greatest academic success in challenging school environments that value academic learning. Highly curious students were expected to show the poorest academic outcomes when situated in schools that were least likely to value and provide learning and growth opportunities.

The present study had several aims. First, we were interested in the potential moderating influence of perceived school quality on the effects of trait curiosity on national achievement test scores and school grades. Second, most studies of positive traits are conducted in isolation without consideration of construct specificity. With few existing studies of curiosity in China, we examined how the hypothesized model compared to alternative, competing models involving self-esteem and happiness. Both self-esteem and happiness might account for academic achievement as "main effects" or conjointly with the school environment. The self-esteem of students in Hong Kong is often derived from success in culturally valued activities: education, family honor, and being respectful of social norms. A longitudinal study of adolescents in Hong Kong found support for reciprocal relations between self-esteem and academic achievement (Marsh et al. 2002). The happiness and quality of life of American youth are associated with and lead to high academic achievement (Frisch et al. 2005; Huebner and Gilman, 2006; Suldo et al., 2006). Additionally, happiness is relevant to success as measured by a wide variety of intrapersonal and interpersonal outcomes (Lyubomirsky et al. 2005). Third, besides perceived school environment, we examined whether objective measures of school academic quality would positively relate to and moderate the effects of curiosity on academic achievement. Fitting with appraisal models, we expected school perceptions to be more important than objective qualities. To address these aims, we initially examined the psychometric properties of curiosity, happiness, and self-esteem measures translated from English into Chinese.

# Methods

#### Participants

Participants included 484 high school students, 268 (55%) girls, 204 (45%) boys (12 did not report their sex). The sample was obtained from 16 classes from 4 secondary schools located in different parts of Hong Kong. About 29% were in 10th grade, 31% in 11th grade, 18% in 12th grade, and 22% in 13th grade. Average age of participants was 16.9 (SD = 1.46). All students were Chinese with 79% born in Hong Kong. About 88% of the participants were from schools that taught in Chinese; 12% were from schools that taught in English.

Academic and school-based outcomes

# Achievement test scores

The Hong Kong Certificate of Education Examination (HKCEE) is a territory-wide (national) public standardized examination for high school students. Chinese, English, and Math HKCEE scores were obtained from each participating school for students in grades 12 and 13. Scores for each examination were scored such that "6" represented an "A", "5" represented a "B", "4" represented a "C", "3" represented a "D", "2" represented an "E", and scores of "1" or below represented worse scores. Students in grades 10 and 11 were asked to predict their achievement test scores.

#### Self-reported academic grades and aspirations

Face-valid items assessed academic grades and aspirations. Grades were self-reported with higher numbers equivalent to better performance such that "6" represented an "A", "5" represented a "B", "4" represented a "C", "3" represented a "D", "2" represented an "E", and scores of "1"

or below represented worse scores. Using a yes/no format, respondents were asked whether they plan to attend university.

#### Academic and school-based predictors

#### Perceived school quality

Students evaluated the degree to which schools "valued and offered academic challenges" to them on a 6-point Likert scale from (1) low to (6) high. This single item assessed perceived school academic challenge or quality.

#### Objective school quality

The average passing rates on Chinese, English, and Math HKCEE scores for grade 11 students were obtained from each school. The average passing rates ranged from 30% to over 90%. We also had data on the percentage of students planning to attend university, ranging from 10 to 49%. These two items were combined to assess the objective academic quality of each school.

#### Trait curiosity, happiness, and self-esteem

Each scale in this section was translated into Chinese by the second author and translated back into English by an independent translator to confirm accuracy of meaning;

 Table 1 Descriptive statistics for demographic characteristics and scales

available upon request from the second author. Table 1 shows alpha coefficients for each scale.

### Curiosity and exploration inventory (CEI)

The 7-item CEI (Kashdan et al. 2004) assesses two dimensions of trait curiosity: approach-oriented strivings for novelty and challenge (4-item Exploration subscale) and the ability to direct and sustain attention toward inherently interesting activities (3-item Absorption subscale). Items are rated on a 7-point Likert scale from (1) strongly disagree to (7) strongly agree. The combined score was used in primary analyses. Prior work shows that the CEI can be reliably differentiated from other positive traits (Kashdan 2002, 2004a, b). Construct validity has been demonstrated in studies showing the CEI predicts greater interest but not enjoyment in increasingly complex polygons (Silvia 2005, in press); other work shows that greater CEI scores are associated with greater sensitivity to everyday events offering novelty and challenge (Kashdan and Steger, 2007).

#### Subjective happiness scale (SHS)

The 4-item Subjective Happiness Scale (Lyubomirsky and Lepper 1999) measures cognitive appraisals of general life satisfaction. Items are rated on a 7-point Likert scale with different descriptors for each item (e.g., some items are rated from "not at all" to "a great deal"). Construct validity has been demonstrated by differential correlations

Descriptive data	Full sample $n = 484$	Grade 10 and 11 students $n = 292$	Grade 12 and 13 students $n = 192$		
Girls (Boys)	268 (204)	158 (126)	110 (78)		
No Sex Reported	12	8	4		
Age (SD)	16.85 (1.46)	16.02 (1.15)	18.08 (.90)		
Perceived school quality—M (SD)	3.47 (1.00)	3.58 (.99)	3.28 (1.00)		
HKCEE Chinese	3.61 (1.10)	3.72 (1.17)	3.44 (.98)		
HKCEE English	3.21 (1.17)	3.49 (1.26)	2.79 (.85)		
HKCEE Math	3.92 (1.28)	3.98 (1.39)	3.82 (1.08)		
Academic grades	3.25 (1.00)	3.27 (1.05)	3.22 (.93)		
% Planning to go to University	77.6%	65.8%	95.4%		
CEI total score—M (SD)	24.77 (5.14)	24.47 (5.16)	25.23 (5.09)		
α	.68	.66	.72		
SHS—M (SD)	18.36 (4.70)	18.28 (4.86)	18.48 (4.45)		
α	.80	.81	.80		
RSE - M(SD)	24.59 (4.38)	24.16 (4.39)	25.25 (4.28)		
α	.87	.88	.86		

*Notes*: HKCEE = Hong Kong Certificate of Education Examination; CEI = Curiosity and Exploration Inventory; SHS = Subjective Happiness Scale; RSE = Rosenberg Self-Esteem Scale

 Table 2
 Zero-order correlations between variables

		1	2	3	4	5	6	7	8
1.	Perceived quality	_	.10	.02	.07	.49	.21	.29	.28
2.	HKCEE Chinese	-	-	.56	.39	.23	.02	.09	.14
3.	<b>HKCEE</b> English	-	-	-	.39	.13	01	.06	.04
4.	HKCEE Math	-	-	-	_	.19	.08	.08	.15
5.	School Grades	-	-	-	_	-	.33	.36	.44
6.	CEI	-	-	-	_	-	-	.38	.44
7.	SHS	-	-	-	_	-	-	-	.54
8.	RSE	_	-	-	-	-	-	-	-

*Notes*: Correlations greater than .10 were statistically significant at p < .05. All p-values were two-tailed. HKCEE = Hong Kong Certificate of Education Examination; CEI = Curiosity and Exploration Inventory; SHS = Subjective Happiness Scale; RSE = Rosenberg Self-Esteem Scale

associated with the SHS compared to measures of selfesteem (Lyubomirsky et al. 2006) and studies showing that happy people are less vulnerable to becoming distressed in response to negative feedback (Lyubomirsky et al. 2001).

# Rosenberg Self-Esteem Scale

The Chinese version of the 10-item Rosenberg Self-Esteem Scale (Rosenberg 1965) was used to assess positive self-regard. Items are rated on a 4-point Likert scale from (1) strongly agree to (4) strongly disagree. Higher scores reflect greater self-esteem. As the most widely used measure of self-esteem, construct validity has been demonstrated by decades of research (Brown and Marshall 2001; Robins et al. 2001).

### Procedure

Approval to collect data was secured through school principals and letters of consent sent to parents. In each of the four participating secondary schools, classes were randomly selected for the study. Students participated in the study with no extra credit or compensation. Survey questionnaires were administered in Chinese by classroom teachers during class periods. Students were instructed to complete questionnaires individually. They were informed that the purpose of the study was to investigate adolescent development.

# Results

Student demographic characteristics and descriptive statistics for primary variables are reported in Table 1. Our sample was composed of students in grades 12–13 who completed national achievement tests and students in grades 10–11 who predicted their scores. Predicted scores of students in grades 10–11 were significantly better (M = 11.20, SD = 3.19) than the actual scores of students in grades 12–13 (M = 10.04, SD = 1.90), t (473) = 4.47, p < .001. There were no grade differences in self-reported school grades. Students in grades 12–13 were more likely to report plans to attend university (95.4%) compared to students in grades 10–11 (65.8%),  $\chi^2$  (1, 438) = 53.19, p < .001. Correlations among study variables are presented in Table 2.

Data analytic procedure for primary analyses

We initially evaluated the psychometric properties of English scales translated into Chinese. A series of confirmatory factor analyses on the CEI, RSE, and SHS were conducted, including tests of invariance across school grade and sex. Following recommendations by Byrne (2001), we specified simultaneous between-group models that (1) allowed parameters to be estimated freely and (2) constrained factor loading patterns and measurement error variances to be equal. Next, we tested hypothesized structural models of whether Trait Curiosity × Perceived School Quality interactions predicted achievement test scores and academic grades. Self-esteem and happiness were included as covariates. Interaction terms were standardized prior to analysis and significant interaction effects were explored with simple slope analyses controlling for covariates (Aiken and West 1991). Structural models were followed-up with multigroup analyses to test invariance across school grade (or age).<sup>2</sup>

Even if our hypothesized structural model provided a good fit, there are often good fitting alternative models (Tomarken and Waller 2003). To test model specificity, we examined alternative models of whether the (1) effects of self-esteem or happiness on academic success were moderated by perceived school quality or (2) effects of trait

 $<sup>^2</sup>$  We also tested invariance in the measurement models across boys and girls. We failed to find any statistically significant differences.

curiosity on academic success were moderated by objective school quality (as opposed to perceptions).

All models were tested with the AMOS 6.0 structural equation modeling program (Arbuckle 2005). As a consequence of using a 1-item measure of perceived school quality, we were unable to create latent interactions between latent and observed variables (see Marsh et al. 2004, p. 296).<sup>3</sup> Instead, we formed interactions between the observed measure of perceived school quality and observed total score of relevant trait measures (e.g., curiosity, happiness, and self-esteem).

# Measurement models of Chinese curiosity, happiness, and self-esteem scales

We began by examining measurement models of translated trait measures of curiosity, happiness, and self-esteem to see if they deviated from the original English versions. For the Curiosity and Exploration Inventory (CEI), we tested the original two-factor model with exploration and absorption as separate, correlated factors. The data fit this model,  $\chi^2$  (13) = 31.42, p = .003,  $\chi^2/df = 2.42$ , TLI = .92, CFI = .96, RMSEA = .05, SRMR = .04, but the reverse-scored item four ("I am not the type of person who probes deeply into new situations or things") had an unacceptably low loading (.25) on the latent exploration factor. Upon removing this item, the model fit was improved,  $\chi^2$  (8) = 11.85, p = .16,  $\chi^2/df = 1.48$ , TLI = .98, CFI = .99,

RMSEA = .03, SRMR = .02. For the Subjective Happiness Scale (SHS), we found support for the original one-factor model,  $\chi^2$  (2) = 2.95, p = .23,  $\chi^2/df = 1.48$ , TLI = .99, CFI = .99, RMSEA = .03, SRMR = .02. For the Rosenberg Self-Esteem Scale (RSE), we failed to find adequate support for the original one-factor model,  $\chi^2$  (35) = 202.73, p < .001,  $\chi^2/df = 5.79$ , TLI = .87, CFI = .90, RMSEA = .10, SRMR = .06. Similar to prior examinations in Chinese populations (Cheng and Hamid 1995), item eight ("I wish I could have more respect for myself") had an unacceptably low loading (.22). Upon removing this item and adding two error covariances, the model fit the data well,  $\chi^2$ (29) = 71.06, p < .001,  $\chi^2/df = 2.84$ , TLI = .96, CFI = .97, RMSEA = .06, SRMR = .04.

#### Configural invariance in measurement models

To examine potential cohort variability in measurement models, we used multigroup analyses. As evidence of configural invariance, there were no significant differences by grade for the CEI, SHS, or RSE. Thus, the modified 6-item CEI (deleting one item), 4-item SHS, and modified 9-item RSE (deleting one item) were shown to have adequate reliability (see Table 1 for alpha coefficients) when translated into Chinese.

# Curiosity and school quality as predictors of achievement test scores

With satisfactory measurement models, we examined whether relations between curiosity and HKCEE scores were moderated by school perceptions. The initial structural model fit the data well,  $\chi^2$  (237) = 447.35, p < .001, TLI = .93, CFI = .94, RMSEA = .04,  $\gamma^2/df = 1.89$ , SRMR = .05 (see Fig. 1). As predicted, the relation between the CEI and HKCEE scores was moderated by perceived school quality,  $\beta = .11$ , p = .03. Conditioned at 1 standard deviation below the CEI mean, school quality was not significantly associated with HKCEE scores; conditioned at 1 standard deviation above the CEI mean, perceived school quality was significantly associated with greater HKCEE scores,  $\beta = .48$ , p = .003,  $R^2 \Delta = .20$ . Highly curious students reported greater HKCEE scores when situated in highly challenging schools and the lowest scores (of all students) in non-challenging schools.

#### Testing configural invariance

We obtained objective achievement test scores for students in grades 12–13 whereas students in grades 10–11

<sup>&</sup>lt;sup>3</sup> Several authors detail strategies for creating latent variable interactions (e.g., Little et al. 2006; Marsh et al. 2004). The limitations of using a single item measure of perceived school quality did not allow us to take advantage of these procedures. We initially used the Little et al. stepwise approach: (1) creating product terms between perceived school quality and each of the manifest indicators of the CEI, (2) regressing these product terms on the perceived school quality and CEI items, and (3) using the residuals of these regression models to create indicators of the latent interaction variable (pp. 504-505). Our tests of these models failed to converge after 100,000 iterations. Collinearity between manifest indicators of the latent variable interaction can partially explain convergence failures. Second, we tested the Marsh et al. approach. Marsh et al. clearly state that all indicators from main effects should be used in creating the latent interaction term but "do not reuse any of the information (each of the multiple indicators should be used only once in the formation of the multiple indicators of the latent variable interaction factor)" (p. 296). Thus, our only option was to create interaction terms between the 1-item perceived school quality variable and the highest loading item of the Curiosity and Exploration Inventory (i.e., product term between two 1-item manifest indicators) (see p. 296). These interaction effects were significant and similar in form to interaction terms created by standardizing the observed perceived school quality and the CEI total score variables and multiplying them together (see Figs. 1 and 2). In the absence of multiple indicators for perceived school quality, a more reliable interaction term could be created between observed variables. We used this analytic strategy for interaction effects tested in this paper.



Fig. 1 Final structural model of curiosity and school quality on achievement test scores. *Notes*: Parameter estimates and covariances were standardized. All reported effects were statistically significant at p < .05. School quality and CEI variables were standardized prior to analyses. HKCEE = Hong Kong Certificate of Education Examination; CEI = Curiosity and Exploration Inventory; SHS = Subjective Happiness Scale; RSE = Rosenberg Self-Esteem Scale

predicated their scores. In response to using different measurement strategies, we tested the group invariance of structural pathways in Fig. 1. The only significant decrements in model fit were found following the inclusion of equality constraints on the CEI × School Quality interaction on achievement scores,  $\chi^2$  (1) = 4.67, p = .03, and self-esteem on achievement scores,  $\chi^2$  (1) = 5.91, p = .02, respectively. The interaction effect was significant for students in grades 12–13 reporting actual scores ( $\beta = .11$ ) but not for students in grades 10-11 predicting scores  $(\beta = .04)$ . Self-esteem was significant for students in grades 10–11 predicting scores ( $\beta = .22$ ) but not students in grades 12–13 reporting actual scores ( $\beta = -.03$ ). Due to the confounding of age and measurement strategy, it may be more appropriate to interpret the cohort results separately. The predicted model was supported for actual, but not estimated, HKCEE test scores. Different socialcognitive processes were relevant for actual achievement compared to intentions and outcome expectancies.

#### Alternative models

To examine the specificity of our curiosity model, we tested alternative models with SHS or RSE interacting with school quality to predict achievement scores. These interactions were not statistically significant.

# Curiosity and school quality as predictors of self-reported academic grades

We also examined whether the relation between curiosity and academic grades was moderated by school perceptions. The initial structural model fit the data well,  $\gamma^2$  $(195) = 394.80, p < .001, \chi^2/df = 2.03, TLI = .93, CFI =$ .94, RMSEA = .05, SRMR = .05 (see Fig. 2). As predicted, the relation between the CEI and academic grades was moderated by perceived school quality,  $\beta = .38$ , p < .001. Conditioned at 1 standard deviation below the CEI mean, perceived school quality was not significantly associated with academic grades; conditioned at 1 standard deviation above the CEI mean, perceived school quality was significantly associated with greater academic grades,  $\beta = .55, p < .001, R^2 \Delta = .23$ . Highly curious students reported greater academic grades when situated in highly challenging schools and the lowest grades (of all students) in non-challenging schools.

### Testing configural invariance

We examined whether the primary pathways in Fig. 2 were invariant between grades 10–11 and grades 12–13. Results failed to find changes in overall model fit following the inclusion of equality constraints on structural pathways.

#### Alternative models

We examined alternative models of whether the SHQ or RSE interacted with perceived school quality to predict school grades. These interactions were not statistically significant.

Objective school quality as a moderator of curiosity on academic success

Perceived school quality was shown to moderate the effects of curiosity on academic success. We quantified the objective quality of each school and tested whether it moderated the effects of curiosity on achievement test



Fig. 2 Final structural model of curiosity and school quality on academic grades. *Notes*: Parameter estimates and covariances were standardized. All reported effects were statistically significant at p < .05. School quality and CEI variables were standardized prior to analyses. CEI = Curiosity and Exploration Inventory; SHS = Subjective Happiness Scale; RSE = Rosenberg Self-Esteem Scale

scores and academic grades. There were no statistically significant objective school quality main or interaction effects.

#### Discussion

The present study showed that highly curious students outperform their less curious peers in the classroom and on national achievement tests when they believe their school is a challenging academic environment. When students believe that their school is not challenging, individual differences in curiosity do not relate to academic grades or national achievement scores. As evidence of construct specificity, curiosity effects were independent of individual differences in self-esteem and happiness. Moreover, there was no empirical support for alternative models focusing on objective academic quality, or self-esteem and happiness interacting with school quality to predict academic success.

For highly curious students, their academic motivation primarily stems from an intrinsic desire to access novel and challenging experiences and learn from them (Loewenstein 1994). Highly curious students, open to the challenge of trying to integrate different ideas, performed best in schools perceived to offer opportunities for growth and mastery. In less challenging schools, highly curious students lack access to the learning opportunities they crave. In this suboptimal situation, skills may far exceed the demands of the environment which can lead to disengagement (i.e., apathy, boredom) (Sansone and Smith 2000).

An explicit property of being curious is that tendencies to recognize and seek out novel and challenging experiences inevitably lead to some degree of learning and stretching of skills and knowledge. Deriving pleasure from making the unknown known is a route to personal growth and success. However, threatening and unsupportive environments can squelch curiosity and exploratory behaviors (Peters 1978). Threat can be defined as an environment that fails to support core intrinsic values and related goals and efforts. The outcomes of highly curious students viewing their schools as less academically challenging are analogous to top rated, intrinsically motivated athletes on teams that do not value or invest in winning and in turn, consistently fail. These person-environment mismatches can lead to a quick deterioration in motivation and performance. In the highly competitive academic culture of Hong Kong, a loss of school motivation can have adverse consequences. Poor academic performance can lead to lost opportunities to attain one of the finite collegiate level openings, increasing the difficulty of certain career pursuits. Additional research is needed on the real-world consequences of how curiosity can be disabled by unfavorable environmental conditions.

The results of this study add a layer of complexity to studies that find curiosity as a facilitator of learning and academic achievement in youth (e.g., Ainley et al. 2002; Wavo 2004). The most successful outcomes were found for students possessing high curiosity in schools perceived as valuing, succeeding at, and supportive of academic challenges and success. People derive the most positive experiences in environments that are a greater fit with their dominant personality traits and the most negative experiences when they are in environments that run counter to these sensitivities and goals (Pervin 1968). This personenvironment fit may be particularly important in Chinese cultures where people are more relationally oriented compared to individualistic cultures (Kitayama and Markus 1999). Concerns about obtaining the approval of others and having one's actions be representative of significant others,

increases the importance of being successful at socially valued goals. Academic success is a domain that is valued in Chinese society (Hess and Azuma 1991). In Hong Kong, students' sense of self is partially derived from the values of other important people and thus, academic success is strongly tied to self-worth and well-being (Markus and Kitayama 1991). Although we did not conduct a cross-cultural comparison, we suspect that the benefits of curiosity will be more contingent on the environment in collectivist compared to individualistic cultures.

The mechanisms that account for the interactive effects of curiosity and perceived school quality on academic success require clarification. Appraising the subjects being taught in school as high in novelty-challenge and equal to or slightly exceeding one's coping abilities can serve as prerequisites to state curiosity and the development of mastery goals (Silvia 2006). Another area worthy of focus is the amount of effort and energy available and devoted to academic goal pursuit. Highly curious students in desirable academic environments are likely to feel energized, allowing them to persist at challenges. Conversely, highly curious students in undesirable environments may be easily fatigued by the discrepancy between wanting and lacking challenge. Since perceived but not objective school environment moderated curiosity on academic success, future work can examine interventions targeted to modify appraisals, tolerance for distress, and mentorship relationships that can support self-determination. Targeting socialcognitive processes has the potential to buffer against less mutable social systems.

Curiosity has an appraisal pattern involving the frequent recognition of novelty and challenge and beliefs that one can competently cope with these events. Happiness has an appraisal pattern involving the frequent recognition of pleasure and beliefs that pleasant events are important and should be capitalized (Silvia 2006). Studies of American students show that greater happiness is associated with better academic success (e.g., Suldo et al., 2006) and happiness leads to the production of better problem-solving skills, and convergent and divergent thinking (Lyubomirsky et al. 2005). However, from a person-environment fit perspective, the appraisals and behavior tendencies associated with curiosity are more closely aligned with success in challenging academic environments than happiness. This appraisal model might explain the absence of relations between happiness and academic success. Alternatively, these results may be related to students' tendencies to internalize Hong Kong norms about collectivism; collectivist values might serve as an important moderating variable in future work.

Self-esteem was positively related to grades in school and predicted, but not actual, scores on national achievement tests. There are data to suggest that being in an environment that supports and values academic learning enhances self-esteem. Teachers perceived as supportive of student goal efforts leads to stronger curiosity and competence that independently contribute to greater academic learning (Black and Deci 2000). In a 3-year study of law students, perceiving teachers as supportive led to greater feelings of competence in handling challenges which led to better grades (Sheldon and Krieger 2007). Quasiexperimental designs in different cultures can decompose the causal direction of these relations.

There were two important secondary findings in our study. First, we found support for adequate measurement properties for translated measures of curiosity, happiness, and self-esteem in adolescents from Hong Kong. Only the Rosenberg Self-Esteem Scale has been previously used in adolescents and Chinese populations. Only a few modifications were necessary and each of these scales show promise for continued cross-cultural study. Second, our findings were invariant across different age groups except for the curiosity and perceived school quality interaction on national achievement test scores. Age was perfectly confounded with measurement strategy in that objective scores were obtained for students in higher grades and students in younger grades were asked to predict scores. The interactive effect of curiosity and school quality on achievement scores was only found for the objective, actual scores of older students (not predicted scores or expectancies in younger students). Thus, younger and older adolescents were more similar than different on the measurement of positive traits, average scores, relations among traits, and how these traits related to academic success.

The present study contributes to literature on the benefits of curiosity to academic achievement. Ignoring the moderating influence of social environments leads to an erroneous understanding of how curiosity relates to academic success. There are several limitations to these findings, however. The measure of perceived school academic quality suffers from all the shortcomings of selfreport assessments; our use of a 1-item measure further intensified these shortcomings. A proper test of personenvironment fit would extend beyond the measurement of perceptions to actual environmental conditions reflecting opportunities for novelty, challenge, and personal growth. Although our self-report measures of curiosity, happiness, and self-esteem have been well-validated in the United States, we would be more confident in our findings if there were multiple indicators for these latent constructs. Selfreport measures need to be replicated with other procedures such as experience-sampling techniques, interviews, or behavioral observations. The current findings were a valuable starting point to understand curiosity in context but without prospective or experimental designs, the direction of causality remains unclear.<sup>4</sup> Reciprocal relations can be expected with academic learning leading to a greater awareness of knowledge gaps which can intensify curiosity and even develop long-term interests. Clearly, more dynamic approaches are needed to examine intraindividual relations among feelings of curiosity, appraisals of self and school, and academic success, and interindividual differences such as trait curiosity and collectivism that could moderate these relations. Finally, the cultural distinctions mentioned for China and their possible influence on curiosity, school environments, and academic success require direct testing. The cultural aspects of China may influence how challenge is defined rather than how much it is valued.

In summary, using a large sample of Hong Kong adolescents, high levels of student curiosity were not sufficient to predict successful academic performance. Relations between curiosity and academic success were contingent on positive perceptions about the school environment. The results provide preliminary support for a personenvironment fit approach to curiosity. Additional research can examine whether these findings are unique to the culture of Hong Kong and whether curiosity operates differently in individualistic and collectivist contexts. The synthesis of positive experiences, traits, institutions, and broader cultural qualities is a necessary strategy to understanding and cultivating curiosity and other character strengths.

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<sup>&</sup>lt;sup>4</sup> We tested the directionality of our hypothesized curiosity model to evaluate whether curiosity and academic success predict school perceptions. We failed to find support for a CEI × National Achievement Test Scores interaction on perceived school quality ( $\beta = .00, p = .99$ ) but we did find support for a significant CEI × Academic Grades interaction on perceived school quality ( $\beta = .14, p < .001$ ). Specifically, highly curious students with the best grades evaluated their school as the most challenging. Despite the limitations of our cross-sectional methodology, these findings provide preliminary evidence for the potential bi-directionality of several relations under study.

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