Applied Research in Quality of Life
https://doi.org/10.1007/s11482-023-10232-6

Understanding Students' Subjective and Eudaimonic Well-Being: Combining both Machine Learning and Classical Statistics

Yi Wang[1] · Ronnel B. King[2] · Lingyi Karrie Fu[3] · Shing On Leung[1]

Received: 17 October 2022 / Accepted: 22 September 2023

Abstract
There is a vast literature focusing on students' learning and academic achievement. However, less research has been conducted to explore factors that contribute to student well-being. Rooted in the ecological framework, this study aimed to compare the relative importance of the individual-, microsystem-, and mesosystem-level factors in predicting students' subjective and eudaimonic well-being. Hong Kong data from the Programme for International Student Assessment (PISA) 2018 involving 6,037 students were analyzed. Machine learning (i.e., random forest algorithm) was used to identify the most powerful predictors of well-being. This was then followed by hierarchical linear modelling to examine the parameter estimates and account for the nested structure of the data. Results showed that four variables were the most important predictors of subjective well-being: students' sense of belonging to the school, parents' emotional support, resilience, and general fear of failure. For eudaimonic well-being, resilience, mastery goal orientation, and work mastery were the most important predictors. Theoretical and practical implications are discussed.

Keywords Subjective well-being · Eudaimonic well-being · Large-scale assessment · Machine learning · Hong Kong students · PISA 2018

✉ Ronnel B. King
ronnel.king@gmail.com

[1] Faculty of Education, University of Macau, Taipa Macau, SAR, China

[2] Department of Curriculum and Instruction, Faculty of Education, The Chinese University of Hong Kong, Hong Kong, SAR, China

[3] Department of Health and Kinesiology, College of Health, University of Utah, Salt Lake City, UT, US

Published online: 10 November 2023

Introduction

Many students around the globe suffer from low levels of well-being. For example, a report from the Organisation for Economic Co-operation and Development (OECD) revealed that 55% of students were suffering from anxiety when taking a test, and around 66% of students reported that they were stressed about their grades (OECD, 2017). Furthermore, around 7% of students reported very low levels of life satisfaction, and 13% of students had more negative emotions than positive emotions on a typical day (van Zanden et al., 2020).

In the latest round of the Programme for International Student Assessment (PISA) 2018, the level of Chinese students' well-being was significantly lower than their international peers. Moreover, 41% of Chinese students were not satisfied with their lives (Peña-López, 2019). In Hong Kong, adolescents are at an increased risk for low levels of well-being (Lau and Bradshaw, 2018; Legislative Council Secretariat, 2018; Lo, 2021; Qu et al., 2021; Shek & Li, 2014; Shek & Lin, 2017; Xiang et al., 2020) as they face fierce academic competition and immense pressure to succeed from society and family (Lee et al., 2006; Quach et al., 2015). The competitive nature of the Hong Kong educational system places high expectations and gives great pressure to students, undermining their well-being. Consequently, Hong Kong students have excellent academic performance, but poor well-being (Peña-López, 2019). Poor well-being has been proven to be associated with maladaptive school outcomes, such as emotional problems, risk behaviors, and underachievement (Kaess et al., 2014). Given that well-being is critical to students' school outcomes, such as interpersonal relationships and academic performance (Leung et al., 2021; Lyubomirsky et al., 2005), research on student well-being is urgently needed.

Despite the number of studies that explored the factors related to students' well-being, most of them have two key limitations. First, well-being is a complex construct consisting of multiple dimensions, including subjective and eudaimonic well-being (Martela & Sheldon, 2019; Wilson Fadiji et al., 2021; Ryan & Deci, 2001). Previous studies, especially those focusing on students, have mostly focused on the determinants of subjective well-being (e.g., Huang, 2021; Lampropoulou, 2018; Liu et al., 2016). Eudaimonic well-being and its antecedents have received less attention. Given the multi-faceted nature of well-being, this study investigated both subjective and eudaimonic well-being. Second, past studies on well-being have mostly focused on a limited set of antecedents (e.g., Bailey & Phillips, 2016; Lampropoulou, 2018). For example, Lampropoulou (2018) investigated the roles that personality, school, and family play in students' subjective well-being. Given that well-being is simultaneously affected by many different factors (Diener et al., 2009), a more comprehensive framework (e.g., ecological framework) is needed that considers a diversity of variables that are potentially associated with well-being.

Literature review

Subjective Well-Being and Eudaimonic Well-being

Well-being can be conceptualized from the perspectives of subjective well-being and eudaimonic well-being (Diener et al., 2009; Ryff & Singer, 2008). Subjective

well-being has three major components: positive affect, negative affect, and life satisfaction (see Busseri & Sadava, 2011 for a review). Positive and negative affect pertain to positive and negative emotions, respectively. Life satisfaction refers to the cognitive evaluation of one's life. People with a high level of subjective well-being are more likely to experience more positive affect, life satisfaction, and less negative affect.

Eudaimonic well-being refers to the fulfillment of one's potential and striving for excellence (Waterman, 2008). It is typically comprised of specific facets such as mastery, acceptance, and autonomy among others (Ryff & Singer, 2008). However, among the different facets of eudaimonic well-being, one of the most common ways to operationalize it is through meaning in life (e.g., Steger, 2005; Wang et al., 2021; Waterman et al., 2010). Meaning in life is defined as the degree to which individuals perceive themselves to have a sense of purpose and be part of something bigger than themselves (Steger, 2009). It is one of the integral components of eudaimonic well-being and has been found to be closely associated with happiness and pleasure (Ryan et al., 2008). Furthermore, meaning in life is associated with a focus on intrinsic goals, self-reflection, and mindfulness (Ryan & Deci, 2004). Given that the presence of meaning in life is critical to eudaimonic well-being (Peterson et al., 2005; Ryan & Deci, 2001), this study adopted the construct of meaning in life to capture students' eudaimonic well-being.

Theoretical Perspective: The Ecological Framework

The ecological framework, developed by Bronfenbrenner (1979), provides a framework that illustrates the interactions between individuals and their surroundings (Allen et al., 2021). It acknowledges that human functioning is affected by social-ecological factors from multiple layers of environmental systems, i.e., individuals, microsystem, mesosystem, exosystem, and the macrosystem (Bronfenbrenner, 1979). In the educational context, the ecological framework highlights the importance of various school, family, and individual factors within systems in understanding students' well-being (Garbarino, 2014).

A large body of work on well-being has used the ecological framework to examine how environmental factors are associated with well-being (e.g., Garbarino, 2014; Lawler et al., 2017; Tissington, 2008). As suggested by Grouzet and Lee (2014), the ecological system involves the health of the environment that is closely related to human quality of life and well-being.

In the educational context, Oberle et al. (2011) found that personal ecological factors (i.e., neighborhood, school, family, and peer influences) were significantly associated with students' life satisfaction across 25 public elementary schools. In another study, Lawler et al. (2017) used the ecological framework to understand students' subjective well-being across 11 countries. They found that family, school, and peer relationships were the strongest predictors of subjective well-being. Although these studies contributed to the literature on well-being from the perspective of ecological theory, most of these paid attention to subjective but not to eudaimonic well-being.

We categorized all factors from PISA 2018 into three layers of the system, i.e., individual system, microsystem, and mesosystem. The individual level is the center of the ecological framework, involving students' biological and innate characteristics that may affect their well-being (e.g., resilience in Yıldırım & Arslan, 2020). The microsystem level refers to interactions in the individuals' immediate environment (Tissington, 2008). The mesosystem level, in this study, included school climate (e.g., the disciplinary climate in Kutsyuruba et al., 2015), teachers' instruction (e.g., teacher support in Suldo et al., 2009), and perceptions of schools (e.g., sense of belonging in Awartani et al., 2008). Details of each system are described in the following sections.

Individual System

Individual factors include students' demographic variables (i.e., gender and grade), motivation (i.e., competitiveness, work mastery, general fear of failure, mastery goal orientation, and expected occupational status), engagement (i.e., effort, joy, and learning time), self-efficacy (i.e., resilience), and self-concept (i.e., perception of competence and perception of difficulty).

Demographic variables have a significant impact on student well-being. Specifically, students' gender was frequently studied as one of the most important factors affecting their well-being (e.g., Liu et al., 2016). Many studies found that girls generally reported a lower level of well-being than boys as they were more likely to experience negative emotions and had more fragile interpersonal relationships (Benenson & Christakos, 2003; Flook, 2011; LaFontana & Cillessen, 2010). In addition to gender, grade level is also important for students' well-being (Lin & Shek, 2019). Students from lower grade levels reported more life satisfaction and positive affect but less negative affect than those in higher grades, because of the increasing academic pressure as they move into higher grade levels (Liu et al., 2016).

Motivation is broadly defined as the driving force for individuals' actions (Jansen et al., 2022). PISA 2018 included different motivation factors such as competitiveness (i.e., the desire to outperform others), work mastery, mastery goal orientation (i.e., the desire to work hard to master tasks relative to self-defined standards), fear of failure (i.e., the general tendency to avoid potential mistakes and failures), and expected occupational status (OECD, 2019). Motivation closely relates to students' psychological health and satisfaction with their school life (Karaman & Watson, 2017; Ryan & Deci, 2017). Students with high motivation were more likely to experience greater subjective well-being and meaning in life (Bailey & Phillips, 2016). On the contrary, a low level of motivation (e.g., fear of failure and low competitiveness) was negatively related to positive emotions and life satisfaction (Lever et al., 2005). In particular, fear of failure is characterized by an avoidance of evaluative settings where individuals experience shame and failure (McGregor & Elliot, 2005). For example, it was found that fear of failure might lead to negative behaviors (e.g., procrastination and withdrawal) and negative feelings (e.g., helplessness and self-worthlessness), resulting in a low level of subjective well-being (Huang, 2021; King et al., 2023). Expected occupational status is another crucial motivational factor

affecting students' well-being, as it refers to career and life goals, which are closely associated with meaning in life among Hong Kong adolescents (Yuen et al., 2020).

Students' engagement refers to active involvement in effective practices and commitment to learning (Christenson et al., 2012). Student engagement has also been found to be an important predictor of well-being. For example, students' emotional (i.e., the feelings students have toward learning activities, such as enjoyment) and cognitive engagement (i.e., mental effort students spend on learning tasks, such as effort in learning) were found to be key determinants of well-being (King & Frondozo, 2022; Pietarinen et al., 2014). In a longitudinal study by Datu and King (2018), it was also found that prior engagement had significant effects on predicting subsequent subjective well-being. However, few studies have explored the association between student engagement and eudaimonic well-being. Waterman et al., (2010) found that engagement in meaningful activities could lead to feelings of fulfillment and a sense of meaning. It is thus possible that students with higher academic engagement might also develop higher levels of eudaimonic well-being.

Another important individual factor affecting well-being is self-efficacy, which is generally defined as the confidence to carry out behaviors necessary to accomplish specific goals (Bandura, 1977). PISA 2018 measured students' general sense of efficacy in the face of adversity, which was operationalized as resilience (Peña-López, 2019; Wang et al., 2022, 2023a;). Resilience is generally defined as the ability to recover from adversity or negative experiences (Tugade & Fredrickson, 2004). Students who had high levels of resilience reported better overall well-being (Chow et al., 2018; Hartson et al., 2021), subjective well-being (e.g., Noor & Alwi, 2013), and eudaimonic well-being (e.g., Di Fabio & Palazzeschi, 2015).

Self-concept is defined as students' perceptions of their academic abilities (OECD, 2019). Previous studies have found that higher self-concept was related to better life satisfaction and psychological well-being (Matteucci & Soncini, 2021; Raggi et al., 2010). Self-concept includes two components: perception of competence and perception of difficulty (OECD, 2019).

Perceived competence pertains to students' efficacy and control over one's learning outcomes (OECD, 2019). On the opposite end is perceived difficulty, which refers to students' evaluation of task difficulty (Efklides, 2002; Nuutila et al., 2021). The satisfaction of competence, one of the key psychological needs, was found to promote students' optimal well-being (Ryan & Deci, 2017).

Microsystem

Microsystem factors include family background variables (i.e., immigration status, socio-economic status (SES), and duration in early childhood education and care) and parental support. Family background was documented as a strong factor affecting well-being in the literature (Corak et al., 2011). For example, students from low SES families were more likely to experience negative emotions and a low sense of purpose in life (Chen, 2004; Ryff & Singer, 2008). Many other family background factors were also found to influence students' well-being, such as immigration status (Harker, 2001) and early childhood education (Reynolds et al., 2011).

In addition, it was found that parental emotional support is associated with reduced risks of mental illness and higher self-esteem (Boudreault-Bouchard et al., 2013). As a result, students who perceived emotional support from parents usually experienced more subjective and eudaimonic well-being (Winakur, 2011).

Mesosystem

Mesosystem factors are mainly related to the school climate (e.g., school belonging, bullying, and perception at schools) and teachers' instruction (e.g., support, directed instruction, and feedback). Among the factors related to school climate, school belonging was consistently identified as an important predictor of well-being (e.g., Gillison et al., 2008; Tian et al., 2016; Pittman and Richmond, 2008). Previous studies have also found that school bullying could lead to negative student outcomes, such as depression, avoidance, and fear, resulting in mental illness (Klomek et al., 2007; Varela et al., 2021; Vidourek et al., 2016).

OECD also measured students' perceptions of competition and cooperation in the school setting (OECD, 2019). Previous studies have found a negative relationship between competition and emotional well-being (Hoferichter & Raufelder, 2017). On the contrary, cooperativeness was positively correlated with well-being outcomes, such as emotional maturity, autonomy, and high self-esteem (Johnson & Johnson, 2009).

Regarding teachers' instruction, teaching strategies are prominent factors influencing students' well-being. Prior studies found that high quality of teacher-student interaction was strongly associated with students' well-being (Wang et al., 2021). For example, constructive feedback, stimulation of learning activities, and showing interest from teachers fostered different aspects of students' well-being by enhancing the quality of the teacher-student relationship (Brown et al., 2012; Kusurkar et al., 2011; Schiefele et al., 2013).

Combining Machine Learning Approaches and Classical Statistics

Classical statistics were frequently used to analyze the data in previous well-being studies (e.g., Hierarchical Linear Modeling by Wang et al., 2021; Linear Regression by Bailey and Phillips, 2016; Structural Equation Modeling by Xiang et al., 2016). Classical statistics allow us to compute the magnitude of the relationship among the variables through hypothesis testing. However, classical statistics was originally designed to accommodate a few input variables and a moderate sample size (Ij, 2018). As the number of variables and the sample size increase, the classical statistical approach may lead to an overrepresentation of significant results (Martínez-Abad et al., 2020).

Machine learning approaches might be able to complement classical statistics and help address some of its limitations. Machine-learning approaches have received increasing attention in the educational and psychological literature in recent years (e.g., Iatrellis et al., 2021; Martínez-Abad et al., 2020; Wang et al., 2023a, b). The random forest regression algorithm, one of the key machine learning algorithms, was effective in addressing a wide range of regression issues with

high stability and robustness (Rodriguez-Galiano et al., 2015). A random forest consists of many trees that denote the relative importance of a group of factors (Breiman, 2001). Specifically, the random forest algorithm randomly builds regression trees based on random subsets of the observation and creates each split of a tree based on a random subset of candidate variables (Grömping, 2009). The process is combined with bootstrapping procedures to iteratively minimize the predictive error (Yarkoni & Westfall, 2017). Thus, the random forest has been considered to have high predictive accuracy, which iteratively selects key variables and determines the optimal subset size of factors through k-fold cross-validation (Martínez-Abad et al., 2020).

Random forest is also suitable for dealing with high-dimensional issues involving interaction terms and highly correlated predictors that may violate the collinearity assumption (i.e., independent variables have low correlations with each other) in classical statistics (Lu & Ishwaran, 2018; Strobl & Zeileis, 2008). A key advantage of random forest over classical statistics is that it covers both the effects of each predictor individually and the simultaneous impact of multivariate interactions among predictors (Lunetta et al., 2004). Moreover, the random forest can also be applied in situations when the predictors are highly correlated by randomly selecting variables in each tree. Given the big sample size, the presence of multiple predictors, and the highly correlated nature of the variables in the PISA dataset, random forest approach is especially suited to the current study (see Lezhnina & Kismihók, 2022; Wang et al., 2022, 2023 for other examples of machine learning approaches in PISA studies).

Although machine learning has often been used to explore influential factors of students' learning outcomes, such as achievement (Martinez and Lopez, 2017), learning dropout (Tan & Shao, 2015), and enrollment (Iatrellis et al., 2021), its application in students' well-being research is rather limited (Mendoza et al., 2023). Moreover, given the complexity of well-being and the factors that impinge on it, a large volume of variables and a big dataset may help researchers develop a fuller and more nuanced understanding of student well-being. To achieve this, the current study combined machine learning with classical statistics to identify the most important factors and interpret their effect on students' well-being.

The Hong Kong Context

This study was conducted based on a Hong Kong dataset. Hong Kong is a special administrative region of China. It is an interesting case given that high levels of achievement are accompanied by low levels of well-being among students (Peña-López, 2019). It is well known that there is a competitive academic climate wherein parents and society place high expectations on Hong Kong students (Marsh et al., 2000). Hence, they experience high levels of academic pressure, undermining their sense of well-being (Lee et al., 2006; Quach et al., 2015).

Inevitably, the family climate of students would also be affected. Hong Kong parents have high expectations for their children and they prioritize academic success over socio-emotional well-being (Shek & Chan, 1999; Ma et al., 2018). Some Chinese parents tend to use psychological control by emphasizing their children's failure, which has high emotional costs (Pomerantz et al., 2014). Under these sources of academic stress, students have to work hard and put great effort into academic activities (Xiang et al., 2019), which might lead to excellent academic results but low levels of well-being (Peña-López, 2019). Consequently, studies have shown a significant decline in the life satisfaction of students when their schoolwork increases during their secondary school years (Lee et al., 2006; Ma et al., 2018; Shek & Liu, 2014). The poor well-being experienced by Hong Kong students has piqued the increasing interest of researchers, who are interested in gaining a better understanding of Hong Kong students' well-being (e.g., Lo, 2021; Shek & Li, 2014).

The Present Study

The purpose of this study was to identify the most important factors affecting the subjective and eudaimonic well-being of Hong Kong students. We drew on Bronfenbrenner's ecological framework to classify the relevant variables from PISA 2018 dataset into three layers: individual, microsystem, and mesosystem factors. The conceptual framework is shown in Fig. 1.

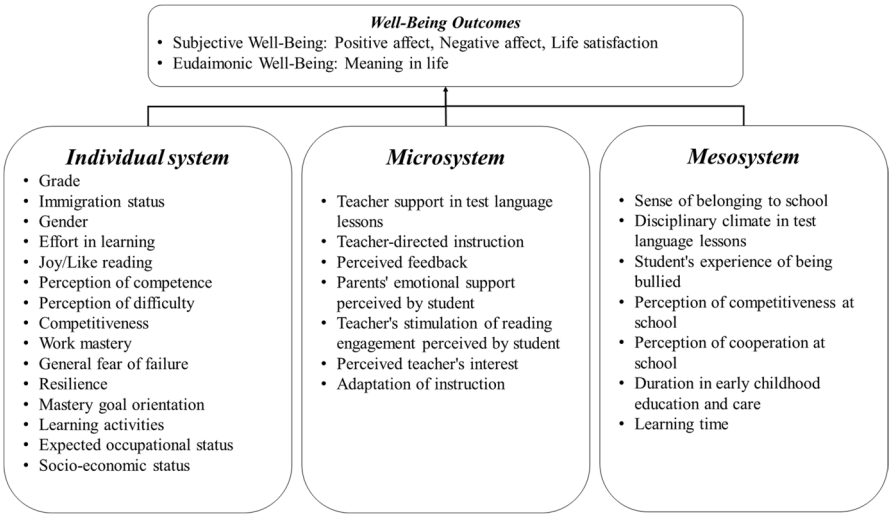

Fig. 1 Conceptual Framework for the Current Study

Methods

Sample

The Programme for International Student Assessment (PISA) 2018 Hong Kong data was used in this study, which was publicly available in the Organisation for Cooperation and Development (OECD) website (https://www.oecd.org/pisa/data/). The sample consisted of 6,037 adolescents from Hong Kong, China. The mean age of the students was 15.73 ($SD = 0.29$). The sample was composed of 51.1% boys and 48.9% girls. Among these students, most of them were in grade 10 (68.0%) and grade 9 (25.0%), others were in grade 7 (0.9%), grade 8 (5.2%), and grade 11 (0.8%).

Measures

Dependent Variables

Subjective well-being was represented by positive affect, negative affect, and life satisfaction. Students reported their positive feelings (five adjectives: "joyful", "cheerful", "happy", "lively", and "proud") and negative feelings (four adjectives: "afraid", "scared", "sad", and "miserable") using a 4-point Likert scale (1 = *Never*, 4 = *Always*). Overall life satisfaction was measured by one item (i.e., "Overall, how satisfied are you with your life as a whole these days?") with an 11-point scale from 0 to 10. Both scales for positive affect (Cronbach's $a = 0.85$) and negative affect (Cronbach's $a = 0.81$) showed adequate internal consistency.

Eudaimonic well-being was operationalized as students' meaning in life by the OECD (OECD, 2019), which is consistent with previous studies (e.g., Ryan & Deci, 2001; Wang et al., 2021). Meaning in life consists of three statements rated on a 4-point Likert scale ranging from 1 (*Strongly disagree*) to 4 (*Strongly agree*). A sample item is: "My life has clear meaning or purpose." This scale had good internal consistency in this study (Cronbach's $a = 0.91$).

Independent Variables

It should be noted that the PISA 2018 dataset includes several different variables (e.g., background information, psychological variables, school, and family variables).

Twenty-nine variables were selected from the student questionnaire in PISA 2018. These variables have been found to be important for students' well-being in the existing literature. All these factors were background variables and composite scores based on item response modelling were calculated by OECD (2019). PISA offers the economic, social, and cultural status (ESCS) as a composite measure of socioeconomic status. It was computed based on three variables — parents' education, home possessions, and family wealth. To avoid multicollinearity problems, we only retained ESCS in our data analysis.

We categorized selected variables into three types according to the ecological framework (See Table 1): individual system (e.g., work mastery, competitiveness, and general fear of failure), microsystem (e.g., teacher support, teacher-directed instruction, and adaptation of instruction), and mesosystem (e.g., sense of school belonging, disciplinary climate, and experience of being bullied). PISA has validated scales for all constructs across countries (OECD, 2020). In addition, all the scales have good content and construct validity according to Borsboom et al.'s (2004) validity theory. All scales had good internal consistency with the high values of Cronbach's *a* ranging from 0.74 to 0.95.

Analytic Strategy

Preliminary analysis

We imputed the missing data using Markov Chain Monte Carlo (MCMC), given its higher rate of estimation accuracy than other methods (Brooks et al., 2011). MCMC was frequently used in PISA studies (e.g., Chiu & Chow, 2010), and it allowed us to include all variables of interest during the data analysis. The descriptive statistics and bivariate correlations among variables were calculated. Before the primary analysis, we standardized all variables with a mean of 0 and a standard deviation of 1.

Primary analysis

There were two steps in the primary analysis. We first identified the most important factors and reduced the number of input variables using the random forest algorithm (Step 1). In the next step, given the nature of nested data, we calculated the effect size to interpret the results with Hierarchical Linear Model (HLM) (Step 2).

In step 1, given the high stability and robustness of the random forest, this study performed a random forest regression algorithm for each well-being dimension using the *randomForest* package in the R statistical software (Liaw & Wiener, 2018). The tenfold cross-validation procedure with five repeats was conducted to select optimal models with almost unbiased prediction error (Simon, 2007). The coefficients of the Root Mean Squared Error (RMSE) were used to estimate the predictive accuracy. The lower the value of RMSE, the higher the accuracy of regression models. The percentage increase of MSE (%IncMSE) was used to indicate the importance of each variable. The higher values of %IncMSE mean that predictive error will be increased more when the variable is removed from the model. In other words, the higher value denotes the greater importance of this variable. The coefficient of determination (R^2) was used to report the proportion of the variation in each well-being outcome that can be explained by the predictors.

In Step 2, given the nested nature of PISA data, we controlled the potential effects of clustering and focused on the effects of student-level variables. The hierarchical structure of PISA may lead to Type I error inflation, and HLM is recommended and the most frequently used in large-scale educational surveys (Areepattamannil, 2014; Lezhnina & Kismihók, 2022). Therefore, we accounted for the nesting of students within schools, by using HLM. We only included the predictor variables selected in the previous step through the random forest algorithm.

Table 1 Variables Used in the Current Study

Code	Variable name	Description	Cronbach's alpha	Items
Well-being outcomes				
SWBP	Positive affect	Frequency of experiencing positive emotions	0.85	1. Thinking about yourself and how you normally feel: how often do you feel as described below? Joyful 2. Thinking about yourself and how you normally feel: how often do you feel as described below? Cheerful 3. Thinking about yourself and how you normally feel: how often do you feel as described below? Happy 4. Thinking about yourself and how you normally feel: how often do you feel as described below? Lively 5. Thinking about yourself and how you normally feel: how often do you feel as described below? Proud
SWBN	Negative affect	Frequency of experiencing negative emotions	0.81	1. How often do you feel as described below? Scared 2. How often do you feel as described below? Miserable 3. How often do you feel as described below? Afraid 4. How often do you feel as described below? Sad
SWBL	Life satisfaction	Overall life satisfaction	-	Overall, how satisfied are you with your life as a whole these days?
EUDA	Eudaimonic well-being	Meaning in life	0.91	1. My life has clear meaning or purpose 2. I have discovered a satisfactory meaning in life 3. I have a clear sense of what gives meaning to my life
Individual factors				
INDI1	GRADE	Grade compared to modal grade in country		-
INDI2	IMMIG	Index Immigration status	-	1. In what country were you and your parents born? You 2. In what country were you and your parents born? Mother 3. In what country were you and your parents born? Father
INDI3	Gender	Student (Standardized) Gender	-	-
INDI4	EFFORT2	The effort student invested in learning	-	How much effort would you have invested?

Table 1 (continued)

Code	Variable name	Description	Cronbach's alpha	Items
INDI5	JOYREAD	Joy/Like reading	0.82	1. I read only if I have to 2. Reading is one of my favourite hobbies 3. I like talking about books with other people 4. For me, reading is a waste of time 5. I read only to get information that I need
INDI6	SCREADCOMP	Self-concept of reading: Perception of competence	0.84	1. I am able to understand difficult texts 2. I read fluently
INDI7	SCREADDIFF	Self-concept of reading: Perception of difficulty	0.79	1. I have always had difficulty with reading 2. I have to read a text several times before completely understanding it 3. I find it difficult to answer questions about a text
INDI8	COMPETE	Competitiveness	0.74	1. I enjoy working in situations involving competition with others 2. It is important for me to perform better than other people on a task 3. I try harder when I'm in competition with other people
INDI9	WORKMAST	Work mastery	0.76	1. I find satisfaction in working as hard as I can 2. Once I start a task, I persist until it is finished 3. Part of the enjoyment I get from doing things is when I improve on my past performance 4. If I am not good at something, I would rather keep struggling to master it than move on to something I may
INDI10	GFOFAIL	General fear of failure	0.80	1. When I am failing, I worry about what others think of me 2. When I am failing, I am afraid that I might not have enough talent 3. When I am failing, this makes me doubt my plans for the future

Table 1 (continued)

Code	Variable name	Description	Cronbach's alpha	Items
INDI11	RESILIENCE	Resilience	0.81	1. I usually manage one way or another 2. I feel proud that I have accomplished things 3. I feel that I can handle many things at a time 4. My belief in myself gets me through hard times 5. When I'm in a difficult situation, I can usually find my way out of it
INDI12	MASTGOAL	Mastery goal orientation	0.87	1. My goal is to learn as much as possible 2. My goal is to completely master the material presented in my classes 3. My goal is to understand the content of my classes as thoroughly as possible
INDI13	ATTLNACT	Attitude towards school: learning activities	0.87	1. Trying hard at school will help me get a good job 2. Trying hard at school will help me get into a good < college > 3. Trying hard at school is important
INDI14	BSMJ	Student's expected occupational status (SEI)	-	-
INDI15	ESCS	Index of economic, social and cultural status	-	1. Parents' education 2. Home possessions 3. Cultural possessions at home 4. home educational resources 5. Parental occupational status
Microsystem				
Micro1	TEACHSUP	Teacher support in test language lessons	0.92	1. The teacher shows an interest in every student's learning 2. The teacher gives extra help when students need it 3. The teacher helps students with their learning 4. The teacher continues teaching until the students understands

Table 1 (continued)

Code	Variable name	Description	Cronbach's alpha	Items
Micro2	DIRINS	Teacher-directed instruction	0.88	1. The teacher sets clear goals for our learning 2. The teacher asks questions to check whether we have understood what was taught 3. the teacher presents a short summary of the previous lesson 4. The teacher tells us what we have to learn
Micro3	PERFEED	Perceived feedback	0.90	1. The teacher gives me feedback on my strengths in this subject 2. The teacher tells me in which areas I can still improve 3. The teacher tells me how I can improve my performance
Micro4	EMOSUPS	Parents' emotional support perceived by student	0.87	1. My parents support my educational efforts and achievements 2. My parents support me when I am facing difficulties at school 3. My parents encourage me to be confident
Micro5	STIMREAD	Teacher's stimulation of reading engagement perceived by student	0.89	1. The teacher encourages students to express their opinion about a text 2. The teacher helps students relate the stories they read to their lives 3. The teacher shows students how the information in texts builds on 4. The teacher poses questions that motivate students to participate actively
Micro6	TEACHINT	Perceived teacher's interest	0.87	1. It was clear to me that the teacher liked teaching us 2. The enthusiasm of the teacher inspired me 3. It was clear that the teacher likes to deal with the topic of the lesson 4. The teacher showed enjoyment in teaching

Table 1 (continued)

Code	Variable name	Description	Cronbach's alpha	Items
Micro7	ADAPTIVITY	Adaptation of instruction	0.86	1. The teacher adapts the lesson to my class's needs and knowledge 2. The teacher provides individual help when a student has difficulties 3. The teacher changes the structure of the lesson on a topic that most
Mesosystem				
Meso1	BELONG	Sense of belonging to school	0.77	1. I feel like an outsider (or left out of things) at school 2. I make friends easily at school 3. I feel like I belong at school 4. I feel awkward and out of place in my school 5. Other students seem to like me 6. I feel lonely at school
Meso2	DISCLIMA	Disciplinary climate in test language lessons	0.91	1. Students don't listen to what the teacher says 2. There is noise and disorder 3. The teacher waits along for students to quiet down 4. Students cannot work well 5. Students don't start working for a long time after the lesson begins
Meso3	BEINGBULLIED	Student's experience of being bullied	0.86	1. Other students left me out of things on purpose 2. Other students made fun of me 3. I was threatened by other students 4. Other students took away or destroyed things that belonged to me 5. I got hit or pushed around by other students 6. Other students spread nasty rumours about me

Table 1 (continued)

Code	Variable name	Description	Cronbach's alpha	Items
Meso4	PERCOMP	Perception of competitiveness at school	0.89	1. Students seem to value competition 2. It seems that students are competing with each other 3. Students seem to share the feeling that competing with each other is important 4. Students feel that they are being compared with others
Meso5	PERCOOP	Perception of cooperation at school	0.95	1. Students seem to value cooperation 2. It seems that students are cooperating with each other 3. Students seem to share the feeling that cooperating with each other is important 4. Students feel that they are encouraged to cooperate with others
Meso6	DURECEC	Duration in early childhood education and care	-	1. How old were you when you started < ISCED 0 > ? 2. How old were you when you started < ISCED 1 > ?
Meso7	TMINS	Learning time (minutes per week)—in total	-	In a normal, full week at school, how many < class periods > are you required to attend in total?

Supplementary analysis

Stepwise regression was used to further explore non-linear relationships among the top factors. The process of the random forest algorithm integrates non-linear relationships (e.g., quadratic and interactions), and excludes less relevant factors from the model (Hastie et al., 2009). However, this procedure is a "black box", and the exact nature of the associations among the factors is unknown. Methodologically, after the number of predictor variables are winnowed down into a more manageable number, stepwise regression can help to "unpack" the effects of quadratic and interaction terms. As this is beyond the scope of this paper, results of the stepwise regression are only presented in the supplementary material.

Results

Preliminary analyses

Table 2 showed the ranks and descriptive statistics of all variables of interest, as well as the coefficients of correlation between each well-being dimension and all independent variables (Bivariate correlation was shown in Table S1 in the supplementary file). Results showed that most selected factors were significantly correlated with at least one aspect of students' well-being.

Step 1 – Identify the most important predictors

We used the random forest regression algorithm to initially generate four predictive models for each well-being element (positive affect, negative affect, life satisfaction, and eudaimonic well-being) with twenty-nine predictors. All factors explained 22.35% of positive affect (MSE = 0.78), 17.64% of negative affect (MSE = 0.82), 22.96% of life satisfaction (MSE = 0.77), and 27.05% of eudaimonic well-being (MSE = 0.73). The coefficients of decrease in accuracy (%IncMSE) showed the variable importance when predicting the different aspects of well-being.

For subjective well-being, several salient factors were found (%IncMSE > 30): school belonging (ranked 1st) and resilience (2nd) for positive affect; General fear of failure for negative affect; Parental support (1st), school belonging (2nd), and resilience (3rd) for life satisfaction. Two dominant factors relating to eudaimonic well-being were resilience (1st) and work mastery (2nd).

Prediction Performance of the Key Factors

We further conducted the tenfold cross-validation with 5 repeats for four well-being outcomes to streamline the prediction model (see Fig. 2). Results showed that the decrease rate of MSE was very slow after the model selected seven factors for

Table 2 Overall Ranks and Descriptive Statistics of all Factors, Correlation between Well-being and the Predictor Variables

				Positive affect			Negative affect			Life satisfaction			Eudaimonic well-being		
Variables	Range	*M*	*SD*	Rank	%IncMSE	*r*	Rank	%IncMSE	*r*	Rank	%IncMSE	*r*	Rank	%IncMSE	*r*
Well-being outcomes															
Positive affect	1—4	3.11	0.53												
Negative affect	1—4	2.81	0.57												
Life satisfaction	0—10	6.27	2.24												
Eudaimonic well-being	1—4	2.74	0.71												
Individual level															
Grade	7—11	9.63	0.64	26	0.94	-.031*	24	2.43	.037**	25	1.73	-.027*	27	0.75	-.041**
Gender	1—2	1.51	0.50	12	8.34	-.105**	4	14.97	-.166**	27	0.81	.021	22	4.62	.040**
Effort	1—13	8.92	1.62	27	0.84	.095**	28	0.92	.046**	21	5.31	.105**	25	2.49	.092**
Joy/Like reading	-2.73—2.7	0.29	0.89	18	5.87	.043**	15	7.02	.034**	22	4.73	.040**	17	10.36	.044**
Perception of competence	-2.57—2.31	-0.23	0.92	13	6.71	.074**	12	8.19	-.018	15	9.44	.077**	16	10.76	.124**
Perception of difficulty	-2.35—2.78	0.15	0.96	21	4.12	-.069**	14	7.04	.121**	20	5.76	-.060**	18	8.16	-.033*
Competitiveness	-2.35—2.96	0.13	0.83	15	6.39	.156**	18	5.09	.013	16	8.21	.118**	13	13.64	.245**
Work mastery	-3.62—2.29	-0.04	0.84	5	11.6	.210**	16	5.97	-.026*	10	12.5	.204**	2	33.84	.336**
General fear of failure	-2.39—2.62	0.40	0.87	11	8.86	-.071**	1	42.44	.343**	4	19.03	-.178**	12	13.85	-.107**
Resilience	-3.46—2.37	-0.29	0.91	2	35.50	.311**	3	19.24	-.160**	3	34.54	.299**	1	51.95	.448**
Mastery goal orientation	-3.91—2.73	-0.06	0.92	16	6.29	.175**	20	4.44	.026*	13	10.45	.172**	3	27.84	.300**
Learning time (minutes per week)	130—4826	1749	357.30	29	-1.21	.002	29	-0.88	.011	29	-0.84	.007	28	0.59	.028*
Student's expected occupational status	3.21—111.46	64.64	17.56	25	1.19	.039**	25	1.24	-.022	24	2.83	.088**	23	4.51	.117**

Table 2 (continued)

Variables	Range	*M*	*SD*	Positive affect			Negative affect			Life satisfaction			Eudaimonic well-being		
				Rank	%IncMSE	*r*	Rank	%IncMSE	*r*	Rank	%IncMSE	*r*	Rank	%IncMSE	*r*
Microsystem															
Index Immigration status	-1—4	1.50	0.70	22	3.53	.027*	27	1.15	-.064**	28	-0.51	-.009	26	2.20	.007
Index of economic, social and cultural status	-6.52—3.37	-0.52	1.02	20	5.31	.025*	22	3.11	.045**	17	7.85	.093**	24	3.08	.055**
Duration in early childhood education and care	0—8	3.20	0.77	28	0.07	.005	26	1.20	.040**	26	1.31	-.027*	29	0.14	.014
Parental supports	-2.81—2.41	-0.36	0.88	3	20.94	.270**	19	4.81	-.080**	1	37.44	.304**	5	20.31	.262**
Mesosystem															
Disciplinary climate in test language	-3.29—3.46	0.25	1.09	23	3.47	.100**	23	2.59	-.063**	23	3.91	.137**	19	7.69	.095**
Student's experience of being bullied	-3.03—3.86	0.11	1.05	19	5.40	-.133**	6	10.57	.156**	19	5.85	-.146**	21	5.12	-.103**
Sense of belonging to school	-3.62—2.72	-0.4	0.70	1	55.00	.390**	2	27.35	-.232**	2	34.57	.320**	4	26.43	.301**
Perception of cooperation at school	-2.43—2.94	0.07	0.93	4	16.27	.244**	17	5.24	-.058**	8	13.42	.251**	9	15.63	.249**
Perception of competitiveness at school	-2.66—3.78	0.42	0.97	24	1.75	.031*	5	12.08	.131**	18	6.49	-.019	20	7.33	.047**
Teacher support	-2.71—2.34	-0.02	0.97	9	10.00	.146**	13	8.02	-.079**	6	14.89	.192**	15	11.54	.162**
Teacher-directed instruction	-2.94—2.7	-0.08	1.06	8	10.69	.132**	9	9.74	-.075**	5	15.7	.175**	10	15.30	.178**
Perceived feedback	-2.88—2.51	0.11	0.90	17	6.11	.127**	7	10.50	-.071**	11	11.66	.176**	11	14.18	.181**

Table 2 (continued)

Variables	Range	*M*	*SD*	Positive affect			Negative affect			Life satisfaction			Eudaimonic well-being		
				Rank	%IncMSE	*r*	Rank	%IncMSE	*r*	Rank	%IncMSE	*r*	Rank	%IncMSE	*r*
Teacher's stimulation	-2.58—2.45	0.12	0.96	6	11.54	.166**	10	9.21	-.035**	12	10.96	.182**	8	15.85	.192**
Perceived teacher's interest	-2.31—2.4	0.05	0.90	7	10.74	.165**	11	8.84	-.039**	7	14.61	.204**	6	16.32	.214**
Adaptation of instruction	-2.31—2.38	0.00	0.94	10	9.72	.127**	8	10.00	-.062**	14	10.28	.170**	14	12.89	.158**
Attitude towards school: learning activities	-3.14—2.57	-0.27	0.91	14	6.47	.164**	21	3.92	-.029*	9	13.26	.191**	7	16.00	.221**

Note. * $p < 0.05$, ** $p < 0.01$

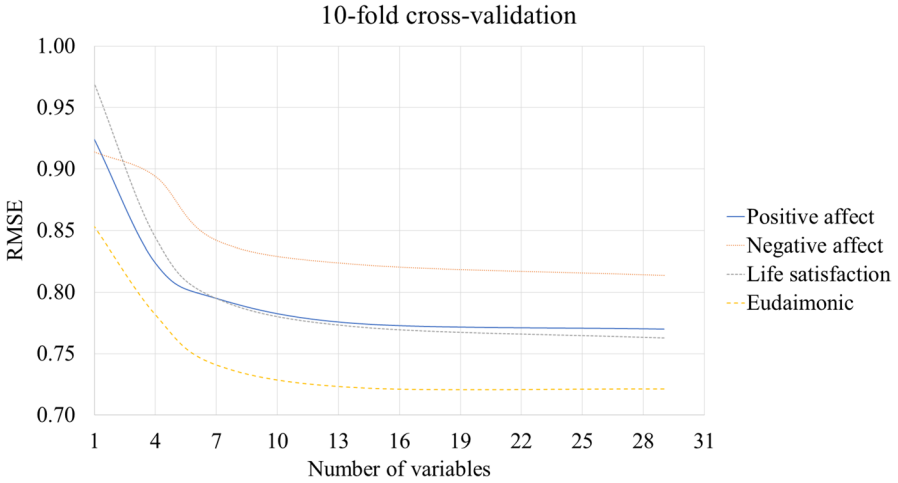

Fig. 2 Prediction Performance of Models with Different Numbers of Predictors

positive affect ($R^2 = 19.15\%$, RMSE = 0.81). Compared to the model with twenty-nine factors, the other nineteen factors only explained the 3.2% variance of positive affect. Therefore, we selected these top seven variables as the key predictors of positive affect. The final model included two individual factors, one in the microsystem, and four in the mesosystem (See the first quadrant in Fig. 3). Among these factors, school belonging was the most salient predictor contributing 84.97% mean decrease in the model accuracy (%IncMSE). Resilience was the second top influential factor contributing to 48.74%IncMSE. Other factors were also important but contributed to less %IncMSE ranging from 14.13% to 23.33%.

We also selected seven dominant factors for negative affect ($R^2 = 14.47\%$, RMSE = 0.86) according to the result of cross-validation. The final model included three individual factors and four factors in the mesosystem (see the second quadrant in Fig. 3). General fear of failure was the top predictor for negative affect, contributing 57.13%IncMSE. School belonging was the second important factor that contributed to the model misfit with 31.38%IncMSE. The values of %IncMSE for other top variables were in the range of 5.42% to 21.33%.

Similarly, seven important factors were obtained for life satisfaction ($R^2 = 19.83\%$, RMSE = 0.80), and eudaimonic well-being ($R^2 = 25.12\%$, RMSE = 0.75). We found that school belonging, parental support, resilience, teachers' support, and interest were five salient predictors of life satisfaction with the range of %IncMSE from 34.19 to 54.35. For eudaimonic well-being, the top influential factors included resilience, mastery goal, work mastery, and school belonging, contributing to the misfit of the model with %IncMSE ranging from 36.30 to 92.42. The selected factors and their ranks within the ecological framework were shown in Fig. 3 (Values of %IncMSE could be found in Fig. 4).

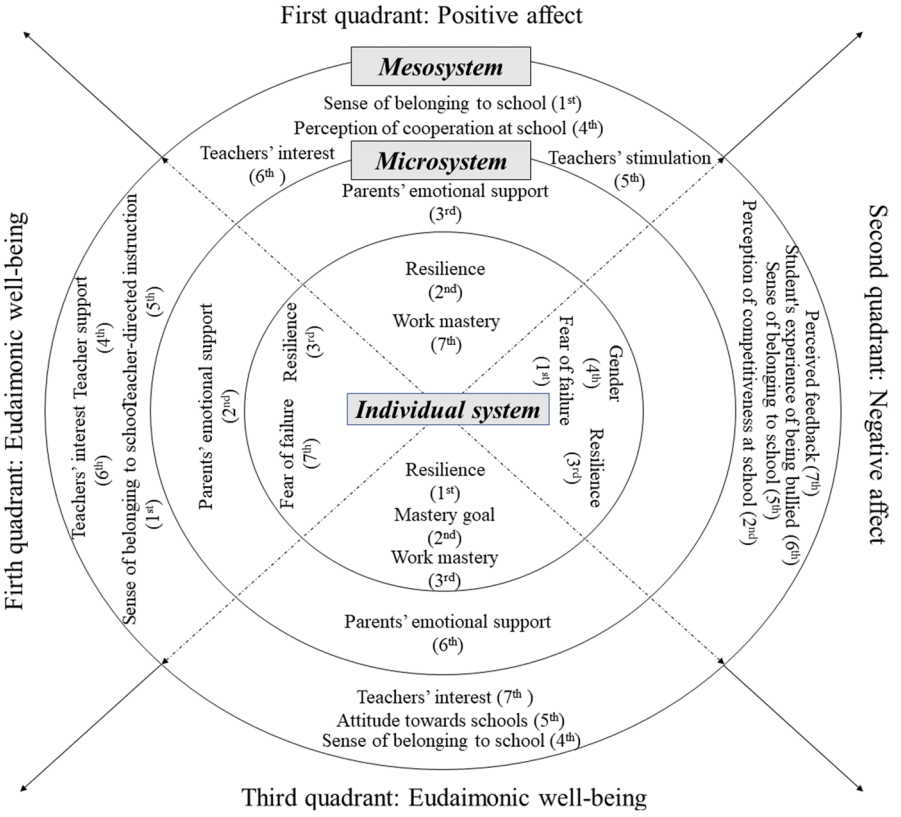

Fig. 3 Key Factors Predicting Well-being Using the Ecological Framework

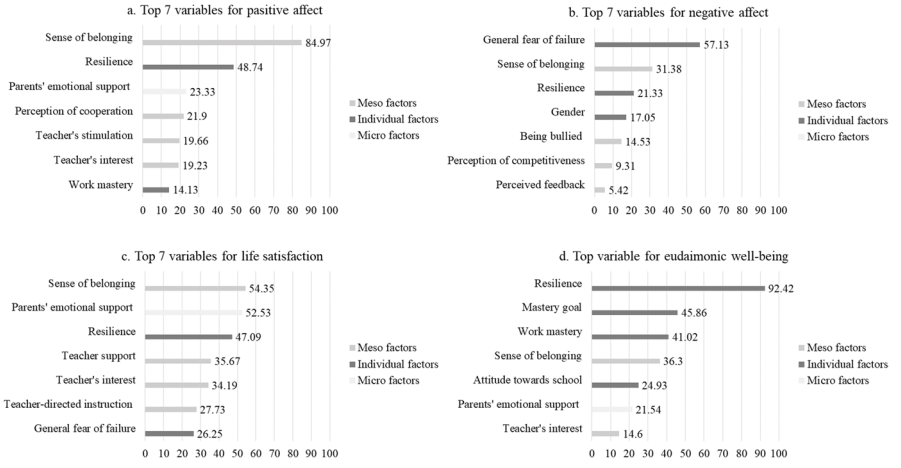

Fig. 4 Top Variables Predicting Different Subjective and Eudaimonic Well-being. *Note:* Positive affect, negative affect, and life satisfaction are components of subjective well-being

Step 2 – Hierarchical Linear Models

The HLM results were shown in Table 3. The within-school variances of well-being outcomes ranged from 0.006 to 0.014, and between-students variances ranged from 0.191 to 0.273. The values of ICC ranged from 0.012 to 0.025. After accounting for the school-level effects, the estimates of factors broadly reflected the importance identified in the random forest algorithm.

Supplementary analyses

The stepwise regression results can be found in the Supplement (See Table S2-S9 in the supplementary file).

Discussion

This study aims to examine the predictors of well-being in Hong Kong. Using the ecological model as the overarching theoretical framework, we identified the top influential factors and their relative importance for Hong Kong students' well-being. The key findings are discussed below.

Individual Factors

For Hong Kong students' positive affect and eudaimonic well-being, resilience, and motivational factors (i.e., work mastery or mastery goals) were key predictors. Both negative affect and life satisfaction were best predicted by fear of failure and resilience. This study revealed that gender was a strong predictor of negative affect. Girls reported more negative emotions than boys. One possible reason might be that the girls were more sensitive to negative events and more likely to catastrophize problems than boys (Garnefski et al., 2004). For example, compared to boys, girls tend to spend more time maintaining friendships as girls' friendships are more fragile and shorter than boys' (Benenson & Christakos, 2003; LaFontana & Cillessen, 2010). Moreover, girls' moods are more likely affected by interpersonal events than boys' (Flook, 2011). In the Hong Kong context, adolescent girls usually experienced more daily hassles and perceived hassles as more stressful than boys during activities such as time management for study and examinations (Hochwälder & Saied, 2018; Lai et al., 1996; Wu & Lam, 1993).

In terms of motivational factors, our results suggested that mastery orientation was particularly crucial in influencing positive affect and eudaimonic well-being, while fear of failure was a predictor of life satisfaction and negative affect. Specifically, students with a high level of intrinsic motivation would experience more positive emotions and higher meaning in life. Moreover, lower fear of failure was associated with more life satisfaction and fewer experiences of negative affect. These findings were not surprising given that the association between motivation and

Table 3 Hierarchical Linear Models with Top 7 Predictors

Positive Affect		Negative Affect		Life Satisfaction		Eudaimonic Well-Being	
Top Factors	*β (SE)*	Top Factors	*β (SE)*	Top Factors	*β (SE)*	Top Factors	*β (SE)*
(Intercept)	0.00 (.014)	(Intercept)	0.00 (.015)	(Intercept)	0.00 (.013)	(Intercept)	0.00 (.015)
Belonging	0.28 (.012) ***	General fear of failure	0.27 (.012) ***	Parental support	0.19 (.012) ***	Resilience	0.29 (.013) ***
Resilience	0.16 (.013) ***	Belonging	-0.15 (.013) ***	Belonging	0.18 (.012) ***	Work mastery	0.10 (.013) ***
Parental support	0.13 (.012) ***	Resilience	-0.07 (.013) ***	Resilience	0.16 (.012) ***	Mastery goals	0.10 (.013) ***
Perception of cooperation	0.08 (.013)	Gender	-0.14 (.013) ***	General fear of failure	-0.14 (.012) ***	Belonging	0.13 (.012) ***
Work mastery	0.02 (.013)	Perception of competitiveness	0.08 (.012) ***	Teacher-directed instruction	0.00 (.017)	Parental support	0.08 (.012) ***
Teacher's stimulation	0.01 (.014)	Being bullied	0.12 (.012) ***	Teacher support	0.06 (.017) ***	Teacher's interest	0.07 (.012) ***
Teacher's interest	0.02 (.014)	Perceived feedback	-0.02 (.012)	Teacher's interest	0.06 (.014) ***	Attitude towards school	0.04 (.012) **
Random Effects							
Root Mean Square Error	0.878		0.893		0.884		0.846
Variance explained at school level	0.012		0.014		0.006		0.014
Variance explained at student level	0.219		0.191		0.213		0.273
Total variance explained	0.231		0.205		0.219		0.287
Intraclass correlation coefficient	0.014		0.025		0.013		0.012

Note. $^{**}p < .01$, $^{***}p < .001$. Standardized coefficients were shown

students' well-being has been documented in a large body of studies (e.g., Bailey & Phillips, 2016; Huang, 2021; Karaman & Watson, 2017). Intrinsically motivated students may achieve better academic outcomes, which in turn promoted their optimal psychological functioning (Ryan & Deci, 2017). On the other hand, fear of failure interfered with the process of goal pursuit, and lack of goal progress might result in a higher negative affect (Berger & Freund, 2012).

Resilience was another vital factor affecting overall well-being. This finding was consistent with previous studies (Chow et al., 2018; Hartson et al., 2021), suggesting that resilience was a protective factor that could promote students' well-being in adverse situations. It might be because students who had high resilience were equipped with more confidence and effective coping skills to recover from adversity and negative emotions (Tugade & Fredrickson, 2004). Therefore, resilience could promote students' well-being and buffer the negative effects of a stressful environment. Moreover, resilience is particularly important for the mental health of students in Hong Kong, who may suffer from depression and suicidal intentions under intensive academic stress (Ang & Huan, 2006).

Microsystem Factors

Parental emotional support was found to be a strong predictor of positive well-being (i.e., positive affect, life satisfaction, and eudaimonic well-being). This echoes several past studies on the strong effect of parent support on students' well-being (e.g., Boudreault-Bouchard et al., 2013; Winakur, 2011). Parental emotional support enhances relatedness between parents and their children, which may be especially helpful when students deal with stressful situations.

An interesting finding was that parental emotional support was not the top factor in affecting negative affect although it was a top predictor of the positive aspects of well-being. This finding corroborates past studies showing that negative and positive aspects of well-being are somewhat orthogonal and are associated with distinct nomological networks (Isen, 2004).

Previous studies suggested that parental support was a protective factor that can reduce the risk of illness (e.g., Boudreault-Bouchard et al., 2013). However, the effects of parental emotional support on students' negative emotions were less than other key factors, suggesting that Hong Kong students' negative emotions are mainly affected by individual- and mesosystem-level factors. Positive and negative affect may be different from life satisfaction. Affect (i.e., feelings during the past three months) is likely to vary across situations, while life satisfaction (i.e., the global judgment of one's life) is more stable (Lucas & Donnellan, 2007). Moreover, according to attachment theory, the parent–child relationship is also relatively stable over time (Bowlby, 1969). Therefore, parental support may have a more powerful effect on life satisfaction given that it are both more stable over time. Positive and negative affect may be more likely to be affected by situational factors. Another potential reason might be the fierce academic competition among Hong Kong students (Marsh et al., 2000), which forces students to strive for higher grades and exacerbates negative feelings (Lee et al., 2006; Quach et al., 2015). Hence, stressors

from the individual- and mesosystem may have a stronger impact on students' negative affect than parental support.

In the Chinese context, familial pressure is one of the main resources of academic stress for students (Gu, 1999). Chinese parents often push their children to strive for academic success, which is considered as family pride, thus they invest much time and effort in their children's education (Chao, 1996). Some Chinese parents use psychological control to urge their children to work diligently (Pomerantz et al., 2014), which leads to poor well-being. In line with past research (Boudreault-Bouchard et al., 2013), this study highlighted the importance of parents' emotional support for enhancing children's well-being outcomes under such a highly pressured environment.

Mesosystem Factors

Five mesosystem factors which related to school climate including school belonging, cooperation, competition, bullying, and attitude toward school were identified as top predictors of students' well-being. A sense of belonging to school was associated with overall well-being. This finding was consistent with previous research on subjective and psychological well-being (Gillison et al., 2008; Tian et al., 2016; Pittman and Richmond, 2008), indicating a strong association between school belonging and well-being. The results also implied that a sense of belonging might be more important than other school climate factors and highlighted the importance of school belonging interventions to promote students' overall sense of well-being (e.g., King et al., 2022; Murphy et al., 2020; Walton & Cohen, 2011).

Cooperation and competition were two key predictors for positive and negative affect, respectively. Working with others was a complex situation. Although some studies suggested that a combination of these two factors would lead to a high level of intrinsic motivation and performance (e.g., Tauer & Harackiewicz, 2004), a negative association between competition and emotional well-being was also shown. The results were consistent with Hoferichter and Raufelder's (2017) study, which found that competition was positively associated with worry and emotionality. In the highly competitive context of Hong Kong, a high-achievement orientation possibly increases students' experiences of such negative emotions (Rappleye et al., 2020).

Bullying was detected as the top predictor of negative affect in this study, which was consistent with previous studies (e.g., Huang, 2021). Bullying is closely accompanied by social rejection and has negative impacts on students' psychological functioning and adjustment in the school context (Olweus & Breivik, 2014).

Attitude toward school learning activities was a key factor for eudaimonic well-being. It suggested that positive attitudes toward school indicated students' strong beliefs in achieving their life goals through school activities.

Several teacher-related instructional factors were also identified as top factors for different aspects of well-being. Teachers' interests greatly impacted the positive facets of well-being (i.e., positive affect, life satisfaction, and eudaimonic well-being). Teachers' stimulation was associated with students' positive affect and life satisfaction. Moreover,

teacher support was an important predictor of life satisfaction. Last, teachers' feedback was found to be a salient factor affecting students' negative affect. These instructional factors were related to the quality of teacher-student interaction. The findings were consistent with previous studies, suggesting that close interactions between teachers and students may enhance student adjustment and emotional functioning by fulfilling their basic needs for autonomy, competence, and relatedness (e.g., Mainhard et al., 2018; Ryan & Deci, 2017; Wang et al., 2021).

Last, we found that some factors investigated in prior studies were less powerful predictors. For example, gender was only found to be important for negative affect, and gender was not that important in predicting the positive aspects of well-being. Furthermore, grade level was not found to be an important predictor which seemed to contradict past studies (Lin & Shek, 2019; Liu et al., 2016). The results did not suggest that gender and grade are not important to aspects of well-being, but relative to other factors, they seemed to be less salient predictors.

Implications

This study contributed to the literature in several ways. Methodologically, this study used the machine learning approach to analyze large-scale assessments that included multiple correlated factors to better understand the top factors influencing well-being. Compared with prior studies that were confined to a limited number of factors, including multiple factors provided an integrative picture of the relative importance of different sets of factors. Moreover, the importance of these factors for various aspects of well-being was different, which has not been sufficiently explored by past studies.

Practically, most of the identified factors are malleable, and they could be improved through educational interventions (e.g., Jessor et al., 2003; Lee et al., 2015; van Agteren et al., 2021). Therefore, the findings of key influential factors of Hong Kong students' well-being offered insights for practitioners and policymakers in decision-making to target critical factors during the design of educational interventions. For example, practitioners could primarily focus on building up students' confidence in facing failure, enhancing school belonging, and preventing school bullying to alleviate students' negative feelings.

Resilience is malleable and several intervention studies suggested that strengthening students' resilience can help to foster positive coping styles which would further benefit students' well-being (e.g., Tam et al., 2020; Wang et al., 2023b; Wu et al., 2020). This study found that resilience was critical to students' well-being. Hence, given the critical role of resilience for both subjective and eudaimonic well-being, educators could help students improve how they respond to stress and adversity. Furthermore, parental support was found to be positively associated with students' positive well-being in this study, indicating that high-quality parental involvement may help improve students' well-being. For example, Wang and Sheikh-Khalil (2014) compared different types of parental involvement in schooling and found that parental involvement could improve students' mental health through fostering students' behavioral and emotional engagement. Hence, parent education programs that would help parents be more supportive might also be important (e.g., Gilmer et al., 2016).

Limitations and Directions for Future Research

There are several limitations of this study. First, given the cross-sectional nature of PISA data, we could not draw any causal relationships between key factors and well-being. Future studies are suggested to validate the effectiveness of the factors identified in this study by tracking how they influence well-being over time with longitudinal or experimental data. Second, limited by the research purpose and the analytical approach, the current study failed to identify how these key factors interacted with each other in contributing to well-being development. The mediation, moderation, and non-linear associations between factors and well-being should be further examined. Third, the type of variables and how they were measured were constrained because we used secondary data from PISA. For example, fear of failure was only measured in a negative manner. In certain cultural contexts, fear of failure might be associated with positive outcomes. For example, research has shown that in collectivist cultural contexts, avoiding failure might not be as harmful as those in individualist contexts (King, 2016). It is possible that fear of failure might also be associated with performance motivation (Elliot & McGregor, 2001). There are some studies though that fear of failure might also have some positive dimensions such as those found among adaptive perfectionists and defensive pessimists who are able to deploy their fear of failure in effective ways (Taylor et al., 2021). Hence, we recommend future studies to measure other variables not included in the PISA dataset.

Conclusion

Rooted in the ecological framework, this study explored the core predictors of Hong Kong students' subjective and eudaimonic well-being using a machine learning approach. We selected individual, microsystem, and mesosystem factors from the PISA dataset and ranked their relative importance. Positive affect was best predicted by school belonging and resilience. Negative affect was best predicted by fear of failure and school belonging. For life satisfaction, school belonging, and parental support were the top predictors. Regarding eudaimonic well-being, resilience, and mastery goals were the most important predictors. These findings are expected to help educators to develop a more holistic understanding of student well-being and provide evidence-based information for practitioners and policymakers to optimize students' well-being.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s11482-023-10232-6.

Declarations

Conflict of Interest The authors declare no other conflicts of interest with respect to the research, authorship, and/or publication of this study.

Ethics This study involving human participants was reviewed and approved by the Human Research Ethics Committee, The University of Hong Kong with reference number EA210477.

This study involved secondary analysis of publicly available and de-identified data. The database can be found in: https://www.oecd.org/pisa/data/2018database/
The authors also obtained an ethics approval from the Human Research Ethics Committee (HREC) of The University of Hong Kong (HREC Reference number: EA210477) to conduct a secondary analyses of the data.

References

Allen, K. A., Fortune, K. C., & Arslan, G. (2021). Testing the social-ecological factors of school belonging in native-born, first-generation, and second-generation Australian students: A comparison study. *Social Psychology of Education, 24*(3), 835–856. https://doi.org/10.1007/s11218-021-09634-x

Ang, R. P., & Huan, V. S. (2006). Relationship between academic stress and suicidal ideation: Testing for depression as a mediator using multiple regression. *Child Psychiatry and Human Development, 37*(2), 133–143. https://doi.org/10.1007/s10578-006-0023-8

Areepattamannil, S. (2014). International note: What factors are associated with reading, mathematics, and science literacy of Indian adolescents? *A Multilevel Examination. Journal of Adolescence, 37*(4), 367–372. https://doi.org/10.1016/j.adolescence.2014.02.007

Awartani, M., Whitman, C. V., & Gordon, J. (2008). Developing instruments to capture young people's perceptions of how school as a learning environment affects their well-being. *European Journal of Education, 43*(1), 51–70. https://doi.org/10.1111/j.1465-3435.2007.00337.x

Bailey, T. H., & Phillips, L. J. (2016). The influence of motivation and adaptation on students' subjective well-being, meaning in life and academic performance. *Higher Education Research & Development, 35*(2), 201–216. https://doi.org/10.1080/07294360.2015.1087474

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*(2), 191–215. https://doi.org/10.1037/0033-295X.84.2.191

Benenson, J. F., & Christakos, A. (2003). The greater fragility of females' versus males' closest same-sex friendships. *Child Development, 74*(4), 1123–1129. https://doi.org/10.1111/1467-8624.00596

Berger, S., & Freund, A. M. (2012). Fear of failure, disorganization, and subjective well-being in the context of preparing for an exam. *Swiss Journal of Psychology, 71*(2), 83–91. https://doi.org/10.1024/1421-0185/a000074

Borsboom, D., Mellenbergh, G. J., & van Heerden, J. (2004). The Concept of Validity. *Psychological Review, 111*(4), 1061–1071. https://doi.org/10.1037/0033-295X.111.4.1061

Boudreault-Bouchard, A. M., Dion, J., Hains, J., Vandermeerschen, J., Laberge, L., & Perron, M. (2013). Impact of parental emotional support and coercive control on adolescents' self-esteem and psychological distress: Results of a four-year longitudinal study. *Journal of Adolescence, 36*(4), 695–704. https://doi.org/10.1016/j.adolescence.2013.05.002

Breiman, L. (2001). Random forests. *Machine Learning, 45*(1), 5–32. https://doi.org/10.1023/A:1010933404324

Bronfenbrenner, U. (1979). *The ecology of human development: Experiments by nature and design*. Harvard University Press.

Brooks, S., Gelman, A., Jones, G., & Meng, X. L. (Eds.). (2011). *Handbook of markov chain monte carlo*. CRC Press.

Brown, G. T., Harris, L. R., & Harnett, J. (2012). Teacher beliefs about feedback within an assessment for learning environment: Endorsement of improved learning over student well-being. *Teaching and Teacher Education, 28*(7), 968–978. https://doi.org/10.1016/j.tate.2012.05.003

Busseri, M. A., & Sadava, S. W. (2011). A review of the tripartite structure of subjective well-being: Implications for on conceptualization, operationalization, analysis, and synthesis. *Personality and Social Psychology Review, 15*, 290–314. https://doi.org/10.1177/1088868310391271

Chao, R. K. (1996). Chinese and European American mothers' beliefs about the role of parenting in children's school success. *Journal of Cross-Cultural Psychology, 27*, 403–427. https://doi.org/10.1177/0022022196274002

Chen, E. (2004). Why socioeconomic status affects the health of children: A psychosocial perspective. *Current Directions in Psychological Science, 13*(3), 112–115. https://doi.org/10.1111/j.0963-7214.2004.00286.x

Chiu, M. M., & Chow, B. W. Y. (2010). Culture, motivation, and reading achievement: High school students in 41 countries. *Learning and Individual Differences, 20*(6), 579–592. https://doi.org/10.1016/j.lindif.2010.03.007

Chow, K. M., Tang, W. K. F., Chan, W. H. C., Sit, W. H. J., Choi, K. C., & Sally, C. H. A. N. (2018). Resilience and well-being of university nursing students in Hong Kong: A cross-sectional study. *BMC Medical Education, 18*(1), 1–8. https://doi.org/10.1186/s12909-018-1119-0

Christenson, S., Reschly, A. L., & Wylie, C. (2012). *Handbook of research on student engagement* (Vol. 840). Springer.

Clark, R. A., Teevan, R., & Ricciuti, H. N. (1956). Hope of success and fear of failure as aspects of need for achievement. *The Journal of Abnormal and Social Psychology, 53*(2), 182–186. https://doi.org/10.1037/h0046496

Conroy, D. E. (2004). The unique psychological meanings of multidimensional fears of failing. *Journal of Sport and Exercise Psychology, 26*, 484–491. https://doi.org/10.1123/jsep.26.3.484

Corak, M., Curtis, L. J., & Phipps, S. (2011). Economic mobility, family background, and the well-being of children in the United States. In T. Smeeding, R. Erikson, & M. Jantti (Eds.), *Persistence, privilege, and parenting*. Russell Sage Foundation.

Cripps, K., & Zyromski, B. (2009). Adolescents' psychological well-being and perceived parental involvement: Implications for parental involvement in middle schools. *RMLE Online, 33*(4), 1–13. https://doi.org/10.1080/19404476.2009.11462067

Datu, J. A. D., & King, R. B. (2018). Subjective well-being is reciprocally associated with academic engagement: A two-wave longitudinal study. *Journal of School Psychology, 69*, 100–110. https://doi.org/10.1016/j.jsp.2018.05.007

Dettmers, S., Yotyodying, S., & Jonkmann, K. (2019). Antecedents and outcomes of parental homework involvement: How do family-school partnerships affect parental homework involvement and student outcomes? *Frontiers in Psychology, 10*, 1048. https://doi.org/10.3389/fpsyg.2019.01048

Di Fabio, A., & Palazzeschi, L. (2015). Hedonic and eudaimonic well-being: The role of resilience beyond fluid intelligence and personality traits. *Frontiers in Psychology, 6*, 1367. https://doi.org/10.3389/fpsyg.2015.01367

Diener, E. (1984). Subjective well-being. *Psychological Bulletin, 95*, 542–575. https://doi.org/10.1037/0033-2909.95.3.542

Diener, E., Diener, M., & Diener, C. (1995). Factors predicting the subjective well-being of nations. *Journal of Personality and Social Psychology, 69*, 851–864. https://doi.org/10.1037/0022-3514.69.5.851

Diener, E., Wirtz, D., Biswas-Diener, R., Tov, W., Kim-Prieto, C., Choi, D. -W., et al. (2009). New measures of well-being. In E. Diener (Ed.), Assessing well-being: *The collected works of Ed Diener,* (pp 247–266). Springer.

Efklides, A. (2002). Feelings and judgments as subjective evaluations of cognitive processing: How reliable are they? *Psychology: The Journal of the Hellenic Psychological Society, 9*(2), 163–182.

Elliot, A. J. (2006). The hierarchical model of approach-avoidance motivation. *Motivation and Emotion, 30*, 111–116. https://doi.org/10.1007/s11031-006-9028-7

Elliot, A. J., & McGregor, H. A. (2001). A 2x2 achievement goal framework. *Journal of Personality and Social Psychology, 83*(3), 501–519. https://doi.org/10.1037/0022-3514.80.3.501

Flook, L. (2011). Gender differences in adolescents' daily interpersonal events and well-being. *Child Development, 82*(2), 454–461. https://doi.org/10.1111/j.1467-8624.2010.01521.x

Garbarino, J. (2014). Ecological perspectives on child well-being'. In A. Ben-Arieh, F. Casas, I. Frones, & J. E. Korbin (Eds.), *Handbook of child well-being: Theories, methods and policies in global perspective.* Springer.

Garnefski, N., Teerds, J., Kraaij, V., Legerstee, J., & van Den Kommer, T. (2004). Cognitive emotion regulation strategies and depressive symptoms: Differences between males and females. *Personality and Individual Differences, 36*(2), 267–276. https://doi.org/10.1016/S0191-8869(03)00083-7

Gillison, F., Standage, M., & Skevington, S. (2008). Changes in quality of life and psychological need satisfaction following the transition to secondary school. *British Journal of Educational Psychology, 78*(1), 149–162. https://doi.org/10.1348/000709907X209863

Gilmer, C., Buchan, J. L., Letourneau, N., Bennett, C. T., Shanker, S. G., Fenwick, A., & Smith-Chant, B. (2016). Parent education interventions designed to support the transition to parenthood: A realist review. *International Journal of Nursing Studies, 59*, 118–133. https://doi.org/10.1016/j.ijnurstu.2016.03.015

Gómez-López, M., Courel-Ibáñez, J., & Granero-Gallegos, A. (2021). Profiles of motivation, fear of failure and anxiety in young handball players: A cross-sectional study. *International Journal of Sports Science & Coaching, 16*(3), 658–669. https://doi.org/10.1177/1747954120975107

Govorova, E., Benítez, I., & Muñiz, J. (2020). Predicting student well-being: Network analysis based on PISA 2018. *International Journal of Environmental Research and Public Health, 17*(11), 4014. https://doi.org/10.3390/ijerph17114014

Grömping, U. (2009). Variable importance assessment in regression: Linear regression versus random forest. *The American Statistician, 63*(4), 308–319.

Grouzet, F. M. E., & Lee, E. S. (2014). Ecological Well-Being. In A. C. Michalos (Ed.), *Encyclopedia of Quality of Life and Well-Being Research.* Springer. https://doi.org/10.1007/978-94-007-0753-5_3966

Gu, Z. (1999). *Investigation of the special subject on conditions of primary and secondary school students' academic burden*. Guangxi Educational Publishing House.

Harker, K. (2001). Immigrant generation, assimilation, and adolescent psychological well-being. *Social Forces, 79*(3), 969–1004. https://doi.org/10.1353/sof.2001.0010

Hartson, K. R., Hall, L. A., & Choate, S. A. (2021). Stressors and resilience are associated with well-being in young adult college students. *Journal of American College Health*, 1–9. https://doi.org/10.1080/07448481.2021.1908309

Hastie, T., Tibshirani, R., Friedman, J. H., & Friedman, J. H. (2009). *The elements of statistical learning: Data mining, inference, and prediction* (Vol. 2, pp. 1-758). Springer.

Hochwälder, J., & Saied, V. (2018). The relation between sense of coherence and daily hassles among university students. *Health Psychology and Behavioral Medicine, 6*(1), 329–339. https://doi.org/10.1080/21642850.2018.1538802

Hoferichter, F., & Raufelder, D. (2017). Competition in class hinders scholastic well-being effects on test anxiety in secondary school students. In K. A. Moore, P. Buchwald,& S. Howard (Eds.), *Stress and anxiety*. Logos.

Huang, L. (2021). Bullying victimization, self-efficacy, fear of failure, and adolescents' subjective well-being in China. *Children and Youth Services Review, 127*, 106084.

Iatrellis, O., Savvas, I. K, Fitsilis, P., & Gerogiannis, V. C. (2021). A two-phase machine learning approach for predicting student outcomes. *Education and Information Technologies, 26*(1), 69–88. https://doi.org/10.1007/s10639-020-10260-x

Ij, H. (2018). Statistics versus machine learning. *Nature Methods, 15*(4), 233–234. https://doi.org/10.1038/nmeth.4642

Isen, A. M. (2004). Some perspectives on positive feelings and emotions: Positive affect facilitates thinking and problem solving. In A. S. R. Manstead, N. Frijda, & A. Fischer (Eds.), *Feelings and emotions: The Amsterdam symposium* (pp. 263–281). Cambridge University Press. https://doi.org/10.1017/CBO9780511806582.016

Jansen, T., Meyer, J., Wigfield, A., & Möller, J. (2022). Which student and instructional variables are most strongly related to academic motivation in K-12 education? A systematic review of meta-analyses. *Psychological Bulletin, 148*(1–2), 1–26. https://doi.org/10.1037/bul0000354

Jessor, R., Turbin, M. S., Costa, F. M., Dong, Q., Zhang, H., & Wang, C. (2003). Adolescent problem behavior in China and the United States: A cross-national study of psychosocial protective factors. *Journal of Research on Adolescence, 13*(3), 329–360. https://doi.org/10.1111/1532-7795.1303004

Johnson, D. W., & Johnson, R. T. (2009). An educational psychology success story: Social interdependence theory and cooperative learning. *Educational Researcher, 38*(5), 365–379. https://doi.org/10.3102/0013189X09339057

Kaess, M., Brunner, R., Parzer, P., Carli, V., Apter, A., Balazs, J. A., ... & Wasserman, D. (2014). Risk-behaviour screening for identifying adolescents with mental health problems in Europe. *European Child & Adolescent Psychiatry*, *23*(7), 611–620. https://doi.org/10.1007/s00787-013-0490-y

Karaman, M. A., & Watson, J. C. (2017). Examining associations among achievement motivation, locus of control, academic stress, and life satisfaction: A comparison of US and international undergraduate students. *Personality and Individual Differences, 111*, 106–110. https://doi.org/10.1016/j.paid.2017.02.006

King, R. B. (2016). Is a performance-avoidance achievement goal always maladaptive? Not necessarily for collectivists. *Personality and Individual Differences, 99*, 190–195. https://doi.org/10.1016/j.paid.2016.04.093

King, R. B., & Frondozo, C. E. (2022). Variety is the spice of life: How emotional diversity is associated with better student engagement and achievement. *British Journal of Educational Psychology*, *92*(1), 19–36. https://doi.org/10.1111/bjep.12436

King, R. B., Chiu, M. M., & Du, H. (2022). Greater income inequality, lower school belonging: Multilevel and cross-temporal analyses of 65 countries. *Journal of Educational Psychology*, *114*(5), 1101–1120. https://doi.org/10.1037/edu0000736

King, R. B., Cai, Y., & Elliot, A. J. (2023). Income inequality is associated with heightened test anxiety and lower academic achievement: A cross-national study in 51 countries. *Learning and Instruction*, *89*, 101825. https://doi.org/10.1016/j.learninstruc.2023.101825

Klomek, A. B., Marrocco, F., Kleinman, M., Schonfeld, I. S., & Gould, M. S. (2007). Bullying, depression, and suicidality in adolescents. *Journal of the American Academy of Child & Adolescent Psychiatry, 46*(1), 40–49.

Kusurkar, R. A., Croiset, G., & Ten Cate, O. T. J. (2011). Twelve tips to stimulate intrinsic motivation in students through autonomy-supportive classroom teaching derived from self-determination theory. *Medical Teacher, 33*(12), 978–982. https://doi.org/10.3109/0142159X.2011.599896

Kutsyuruba, B., Klinger, D. A., & Hussain, A. (2015). Relationships among school climate, school safety, and student achievement and well-being: A review of the literature. *Review of Education, 3*(2), 103–135. https://doi.org/10.1002/rev3.3043

LaFontana, K. M., & Cillessen, A. H. (2010). Developmental changes in the priority of perceived status in childhood and adolescence. *Social Development, 19*(1), 130–147. https://doi.org/10.1111/j.1467-9507.2008.00522.x

Lai, J. C., Hamid, N. P., & Chow, P. (1996). Gender difference in hassles and symptom reporting among Hong Kong adolescents. *Journal of Social Behavior and Personality, 11*(1), 149–164.

Lampropoulou, A. (2018). Personality, school, and family: What is their role in adolescents' subjective well-being. *Journal of Adolescence, 67*, 12–21. https://doi.org/10.1016/j.adolescence.2018.05.013

Lau, M., & Bradshaw, J. (2018). Material well-being, social relationships and children's overall life satisfaction in Hong Kong. *Child Indicators Research, 11*(1), 185–205. https://doi.org/10.1007/s12187-016-9426-7

Lawler, M. J., Newland, L. A., Giger, J. T., Roh, S., & Brockevelt, B. L. (2017). Ecological, relationship-based model of children's subjective well-being: Perspectives of 10-year-old children in the United States and 10 other countries. *Child Indicators Research, 10*(1), 1–18. https://doi.org/10.1007/s12187-016-9376-0

Lee, M. T., Wong, B. P., Chow, B. W. Y., & McBride-Chang, C. (2006). Predictors of suicide ideation and depression in Hong Kong adolescents: Perceptions of academic and family climates. *Suicide and Life-Threatening Behavior, 36*(1), 82–96.

Lee, T. Y., Shek, D. T., & Sun, R. C. (Eds.). (2015). *Student well-being in Chinese adolescents in Hong Kong: Theory, intervention and research (Vol. 7)*. Springer.

Legislative Council Secretariat. (2018). *Overall study hours and student well-being in Hong Kong*. [Information note IN05/17–18]. Retrieved August 26, 2022, from https://www.legco.gov.hk/research-publications/english/1718in05-overall-study-hours-and-student-well-being-in-hong-kong-20180130-e.pdf

Leung, C., Leung, J. T., Kwok, S. Y., Hui, A., Lo, H., Tam, H. L., & Lai, S. (2021). Predictors to happiness in primary students: Positive relationships or academic achievement. *Applied Research in Quality of Life, 16*(6), 2335–2349. https://doi.org/10.1007/s11482-021-09928-4

Lever, J. P., Pinol, N. L., & Uralde, J. H. (2005). Poverty, psychological resources and subjective well-being. *Social Indicators Research, 73*(3), 375–408. https://doi.org/10.1007/s11205-004-1072-7

Lezhnina, O., & Kismihók, G. (2022). Combining statistical and machine learning methods to explore German students' attitudes towards ICT in PISA. *International Journal of Research & Method in Education, 45*(2), 180–199. https://doi.org/10.1080/1743727X.2021.1963226

Liaw, A., & Wiener, M. (2018). *Package 'randomForest.'* University of California.

Lin, L., & Shek, D. T. (2019). The influence of meaning in life on adolescents' hedonic well-being and risk behaviour: Implications for social work. *The British Journal of Social Work, 49*(1), 5–24. https://doi.org/10.1093/bjsw/bcy029

Liu, W., Mei, J., Tian, L., & Huebner, E. S. (2016). Age and gender differences in the relation between school-related social support and subjective well-being in school among students. *Social Indicators Research, 125*(3), 1065–1083.

Lo, H. H. M. (2021). Quality of life among adolescents in Hong Kong: General and gender-specific effects of self-efficacy and mindfulness. *Applied Research in Quality of Life, 16*(6), 2311–2334. https://doi.org/10.1007/s11482-021-09914-w

Lu, M., & Ishwaran, H. (2018). A prediction-based alternative to P values in regression models. *The Journal of Thoracic and Cardiovasccular Surgery, 155*, 1130–1136. https://doi.org/10.1016/j.jtcvs.2017.08.056

Lunetta, K. L., Hayward, L. B., Segal, J., & Van Eerdewegh, P. (2004). Screening large-scale association study data: Exploiting interactions using random forests. *BMC Genetics, 5*(1), 1–13.

Lyubomirsky, S., King, L., & Diener, E. (2005). The benefits of frequent positive affect: Does happiness lead to success? *Psychological Bulletin, 131*(6), 803–855. https://doi.org/10.1037/0033-2909.131.6.803

Ma, Y., Siu, A., & Tse, W. S. (2018). The role of high parental expectations in adolescents' academic performance and depression in Hong Kong. *Journal of Family Issues, 39*(9), 2505–2522. https://doi.org/10.1177/0192513X18755194

Mainhard, T., Oudman, S., Hornstra, L., Bosker, R. J., & Goetz, T. (2018). Student emotions in class: The relative importance of teachers and their interpersonal relations with students. *Learning and Instruction, 53*, 109–119. https://doi.org/10.1016/j.learninstruc.2017.07.011

Marsh, H. W., Kong, C. K., & Hau, K. T. (2000). Longitudinal multilevel models of the big-fish-little-pond effect on academic self-concept: Counterbalancing contrast and reflected-glory effects in Hong Kong schools. *Journal of Personality and Social Psychology, 78*(2), 337–349. https://doi.org/10.1037/0022-3514.78.2.337

Martela, F., & Sheldon, K. M. (2019). Clarifying the concept of well-being: Psychological need satisfaction as the common core connecting eudaimonic and subjective well-being. *Review of General Psychology, 23*(4), 458–474. https://doi.org/10.1177/1089268019880886

Martinez, A. F., & López, C. C. A. A. (2017). Data-mining techniques in detecting factors linked to academic achievement. *School Effectiveness and School Improvement, 28*(1), 39–55.

Martínez-Abad, F., Gamazo, A., & Rodríguez-Conde, M. J. (2020). Educational data mining: Identification of factors associated with school effectiveness in PISA assessment. *Studies in Educational Evaluation, 66*, 100875. https://doi.org/10.1016/j.stueduc.2020.100875

Matteucci, M. C., & Soncini, A. (2021). Self-efficacy and psychological well-being in a sample of Italian university students with and without Specific Learning Disorder. *Research in Developmental Disabilities, 110*, 103858. https://doi.org/10.1016/j.ridd.2021.103858

McGregor, H. A., & Elliot, A. J. (2005). The shame of failure: Examining the link between fear of failure and shame. *Personality and Social Psychology Bulletin, 31*, 218–231. https://doi.org/10.1177/0146167204271420

Mendoza, N. B., King, R. B., & Haw, J. Y. (2023). The mental health and well-being of students and teachers during the COVID-19 pandemic: Combining classical statistics and machine learning approaches. *Educational Psychology*, *43*(5), 430–451. https://doi.org/10.1080/01443410.2023.2226846

Murphy, M. C., Gopalan, M., Carter, E. R., Emerson, K. T., Bottoms, B. L., & Walton, G. M. (2020). A customized belonging intervention improves retention of socially disadvantaged students at a broad-access university. *Science Advances, 6*(29), eaba4677. https://doi.org/10.1126/sciadv.aba467

Noor, N. M., & Alwi, A. (2013). Stressors and well-being in low socio-economic status Malaysian adolescents: The role of resilience resources. *Asian Journal of Social Psychology, 16*(4), 292–306. https://doi.org/10.1111/ajsp.12035

Nuutila, K., Tapola, A., Tuominen, H., Molnár, G., & Niemivirta, M. (2021). Mutual relationships between the levels of and changes in interest, self-efficacy, and perceived difficulty during task engagement. *Learning and Individual Differences, 92*, 102090. https://doi.org/10.1016/j.lindif.2021.102090

Oberle, E., Schonert-Reichl, K. A., & Zumbo, B. D. (2011). Life satisfaction in early adolescence: Personal, neighborhood, school, family, and peer influences. *Journal of Youth and Adolescence, 40*, 889–901. https://doi.org/10.1007/s10964-010-9599-1

OECD. (2013). *OECD guidelines on measuring subjective well-being*. OECD publishing.

OECD. (2017). *Most teenagers happy with their lives but schoolwork anxiety and bullying an issue*. OECD publishing.

OECD. (2019). *PISA 2018 assessment and analytical framework*. OECD publishing.

OECD. (2020). *PISA 2018 technical report*. OECD Publishing.

Olweus, D., & Breivik, K. (2014). Plight of victims of school bullying: The opposite of well-being. Handbook of Child Well-Being, 2593–2616. https://doi.org/10.1007/978-90-481-9063-8_100

Peña-López, I. (2019). *PISA 2018 Results*. OECD publishing.

Peterson, C., Park, N., & Seligman, M. E. (2005). Orientations to happiness and life satisfaction: The full life versus the empty life. *Journal of Happiness Studies, 6*(1), 25–41. https://doi.org/10.1007/s10902-004-1278-z

Pietarinen, J., Soini, T., & Pyhältö, K. (2014). Students' emotional and cognitive engagement as the determinants of well-being and achievement in school. *International Journal of Educational Research, 67*, 40–51. https://doi.org/10.1016/j.ijer.2014.05.001

Pittman, L. D., & Richmond, A. (2008). University belonging, friendship quality, and psychological adjustment during the transition to college. *The Journal of Experimental Education, 76*(4), 343–362. https://doi.org/10.3200/JEXE.76.4.343-362

Pomerantz, E. M., Ng, F. F. Y., Cheung, C. S. S., & Qu, Y. (2014). Raising Happy Children Who Succeed in School: Lessons from China and the United States. *Child Development Perspectives, 8*(2), 71–76. https://doi.org/10.1111/cdep.12063

Qu, D., Huang, J., Yu, N. X., Hui, L. L., & Kouros, C. D. (2021). Association between mother–adolescent relationship quality and subjective well-being: Resilience resources as a mediating factor among Hong Kong Chinese adolescents. *Journal of Child and Family Studies, 30*(8), 1990–2002. https://doi.org/10.1007/s10826-021-01987-3

Quach, A. S., Epstein, N. B., Riley, P. J., Falconier, M. K., & Fang, X. (2015). Effects of parental warmth and academic pressure on anxiety and depression symptoms in Chinese adolescents. *Journal of Child and Family Studies, 24*(1), 106–116. https://doi.org/10.1007/s10826-013-9818-y

Raggi, A., Leonardi, M., Mantegazza, R., Casale, S., & Fioravanti, G. (2010). Social support and self-efficacy in patients with Myasthenia Gravis: A common pathway towards positive health outcomes. *Neurological Sciences, 31*(2), 231–235. https://doi.org/10.1007/s10072-009-0194-8

Rappleye, J., Komatsu, H., Uchida, Y., Krys, K., & Markus, H. (2020). 'Better policies for better lives'?: Constructive critique of the OECD's (mis) measure of student well-being. *Journal of Education Policy, 35*(2), 258–282.

Reynolds, A. J., Temple, J. A., Ou, S. R., Arteaga, I. A., & White, B. A. (2011). School-based early childhood education and age-28 well-being: Effects by timing, dosage, and subgroups. *Science, 333*(6040), 360–364. https://doi.org/10.1126/science.1203618

Rodriguez-Galiano, V., Sanchez-Castillo, M., Chica-Olmo, M., & Chica-Rivas, M. J. O. G. R. (2015). Machine learning predictive models for mineral prospectivity: An evaluation of neural networks, random forest, regression trees and support vector machines. *Ore Geology Reviews, 71*, 804–818. https://doi.org/10.1016/j.oregeorev.2015.01.001

Ryan, R. M., & Deci, E. L. (2001). On happiness and human potentials: A review of research on hedonic and eudaimonic well-being. *Annual Review of Psychology, 52*(1), 141–166. https://doi.org/10.1146/annurev.psych.52.1.141

Ryan, R. M., & Deci, E. L. (2017). *Self-Determination Theory: Basic Psychological Needs in Motivation, Development, and Wellness*. Guilford Press.

Ryan, R. M., Huta, V., & Deci, E. L. (2008). Living well: A self-determination theory perspective on Eudaimonia. *Journal of Happiness Studies, 9*, 139–170. https://doi.org/10.1007/s10902-006-9023-4

Ryan, R. M., & Deci, E. L. (2004). Avoiding death of engaging life as accounts of meaning and culture: Comment on Pyszczynski et al. (2004). *Psychological Bulletin, 130*, 473–477. https://doi.org/10.1037/0033-2909.130.3.473

Ryff, C. D., & Singer, B. H. (2008). Know thyself and become what you are: A eudaimonic approach to psychological well-being. *Journal of Happiness Studies, 9*(1), 13–39. https://doi.org/10.1007/s10902-006-9019-0

Schiefele, U., Streblow, L., & Retelsdorf, J. (2013). Dimensions of teacher interest and their relations to occupational well-being and instructional practices. *Journal for Educational Research Online, 5*(1), 7–37.

Shek, D. T., & Chan, L. K. (1999). Hong Kong Chinese parents' perceptions of the ideal child. *The Journal of Psychology, 133*(3), 291–302.

Shek, D. T., & Li, X. (2014). Subjective well-being of early adolescents in Hong Kong. In D. T. L. Shek, R. C. F. Sun, & C. M. S. Ma (Eds.), *Chinese adolescents in Hong Kong—Family life, psychological well-being and risk behavior* (pp. 93–109). Springer.

Shek, D. T., & Lin, L. (2017). Trajectories of personal well-being attributes among high school students in Hong Kong. *Applied Research in Quality of Life, 12*(4), 841–866. https://doi.org/10.1007/s11482-016-9492-5

Shek, D. T., & Liu, T. T. (2014). Life satisfaction in junior secondary school students in Hong Kong: A 3-year longitudinal study. *Social Indicators Research, 117*(3), 777–794. https://doi.org/10.1007/s11205-013-0398-4

Simon, R. (2007). *Resampling strategies for model assessment and selection In Fundamentals of Data Mining in Genomics and Proteomics* (pp. 173-186). Springer.

Steger, M. F. (2005). *Development and validation of the meaning in life questionnaire: A measure of eudaimonic well-being*. University of Minnesota.

Steger, M. F. (2009). Meaning in life. In S. J. Lopez & C. R. Snyder (Eds.), *Oxford handbook of positive psychology* (pp. 679–687). Oxford University Press.

Strobl, C., & Zeileis, A. (2008). *Danger: High power!–Exploring the statistical properties of a test for random forest variable importance*. University of Munich.

Suldo, S. M., Friedrich, A. A., White, T., Farmer, J., Minch, D., & Michalowski, J. (2009). Teacher support and adolescents' subjective well-being: A mixed-methods investigation. *School Psychology Review, 38*(1), 67–85. https://doi.org/10.1080/02796015.2009.12087850

Sun, R. C., & Shek, D. T. (2012). Student classroom misbehavior: An exploratory study based on teachers' perceptions. *The Scientific World Journal, 2012*, 208907. https://doi.org/10.1100/2012/208907

Tam, C. C., Li, X., Benotsch, E. G., & Lin, D. (2020). A resilience-based intervention programme to enhance psychological well-being and protective factors for rural-to-urban migrant children in China. *Applied Psychology: Health and Well-Being, 12*(1), 53–76. https://doi.org/10.1111/aphw.12173

Tan, M., & Shao, P. (2015). Prediction of student dropout in e-Learning program through the use of machine learning method. *International Journal of Emerging Technologies in Learning, 10*(1), 11–17. https://doi.org/10.3991/ijet.v10i1.4189

Tauer, J. M., & Harackiewicz, J. M. (2004). The effects of cooperation and competition on intrinsic motivation and performance. *Journal of Personality and Social Psychology, 86*(6), 849–861.

Taylor, S., Eklund, R., & Arthur, C. (2021). Fear of failure in sport, exercise, and physical activity: A scoping review. *International Review of Sport and Exercise Psychology*, 1–29. https://doi.org/10.1080/1750984X.2021.1901299

Thrash, T. M., & Elliot, A. J. (2002). Implicit and self-attributed achievement motives: Concordance and predicitive validity. *Journal of Personality, 70*, 729–756. https://doi.org/10.1111/1467-6494.05022

Tian, L., Zhang, L., Huebner, E. S., Zheng, X., & Liu, W. (2016). The longitudinal relationship between school belonging and subjective well-being in school among elementary school students. *Applied Research in Quality of Life, 11*(4), 1269–1285. https://doi.org/10.1007/s11482-015-9436-5

Tissington, L. D. (2008). A Bronfenbrenner ecological perspective on the transition to teaching for alternative certification. *Journal of Instructional Psychology, 35*(1), 106–111.

Tugade, M. M., & Fredrickson, B. L. (2004). Resilient individuals use positive emotions to bounce back from negative emotional experiences. *Journal of Personality and Social Psychology, 86*(2), 320–333. https://doi.org/10.1037/0022-3514.86.2.320

Uchida, Y., & Ogihara, Y. (2012). Personal or interpersonal construal of happiness: A cultural psychological perspective. *International Journal of Wellbeing, 2*(4), 354–369.

van Agteren, J., Iasiello, M., Lo, L., Bartholomaeus, J., Kopsaftis, Z., Carey, M., & Kyrios, M. (2021). A systematic review and meta-analysis of psychological interventions to improve mental wellbeing. *Nature Human Behaviour, 5*(5), 631–652. https://doi.org/10.1038/s41562-021-01093-w

van Zanden, J. L., Rijpma, A., Malinowski, M., & Mira d'Ercole, M. (2020). How's Life? 2020: Measuring Well-being. *OECD Publishing*. https://doi.org/10.1787/9870c393-en

Varela, J. J., Sánchez, P. A., De Tezanos-Pinto, P., Chuecas, J., & Benavente, M. (2021). School climate, bullying and mental health among Chilean adolescents. *Child Indicators Research, 14*, 2249–2264.

Vidourek, R. A., King, K. A., & Merianos, A. L. (2016). School bullying and student trauma: Fear and avoidance associated with victimization. *Journal of Prevention & Intervention in the Community, 44*(2), 121–129. https://doi.org/10.1080/10852352.2016.1132869

Walton, G. M., & Cohen, G. L. (2011). A brief social-belonging intervention improves academic and health outcomes of minority students. *Science, 331*(6023), 1447–1451. https://doi.org/10.1126/science.1198364

Wang, Y., King, R. B., Wang, F., & Leung, S. O. (2021). Need-supportive teaching is positively associated with students' well-being: A cross-cultural study. *Learning and Individual Differences, 92*, 102051. https://doi.org/10.1016/j.lindif.2021.102051

Wang, F., King, R. B., & Leung, S. O. (2022). Beating the odds: Identifying the top predictors of resilience among Hong Kong students. *Child Indicators Research, 15*(5), 1921–1944. https://doi.org/10.1007/s12187-022-09939-z

Wang, F., King, R. B., Fu, L., Chai, C. S., & Leung, S. O. (2023a). Overcoming adversity: exploring the key predictors of academic resilience in science. *International Journal of Science Education*, 1-25. https://doi.org/10.1080/09500693.2023.2231117

Wang, F., King, R. B., & Leung, S. O. (2023b). Why do East Asian students do so well in mathematics? A machine learning study. *International Journal of Science and Mathematics Education, 21*(3), 691–711. https://doi.org/10.1007/s10763-022-10262-w

Waterman, A. S. (2008). Reconsidering happiness: A eudaimonist's perspective. *The Journal of Positive Psychology, 3*(4), 234–252. https://doi.org/10.1080/17439760802303002

Waterman, A. S., Schwartz, S. J., Zamboanga, B. L., Ravert, R. D., Williams, M. K., Bede Agocha, V., ... & Brent Donnellan, M. (2010). The Questionnaire for Eudaimonic Well-Being: Psychometric properties, demographic comparisons, and evidence of validity. *The Journal of Positive Psychology, 5*(1), 41–61. https://doi.org/10.1080/17439760903435208

Wilson Fadiji, A., Meiring, L., & Wissing, M. P. (2021). Understanding well-being in the Ghanaian context: Linkages between lay conceptions of well-being and measures of hedonic and eudaimonic well-being. *Applied Research in Quality of Life, 16*(2), 649–677. https://doi.org/10.1007/s11482-019-09777-2

Winakur, E. (2011). *The roles of perceived parental style and support in goal pursuit and well-being in emerging adults.* University of Miami. Retrieved August 26, 2022, from https://search.proquest.com/openview/173ec11420a854de0ec23aea008da166/1?p

Wu, K. K., & Lam, D. J. (1993). The relationship between daily stress and health: Replicating and extending previous findings. *Psychology and Health, 8*(5), 329–344. https://doi.org/10.1080/08870449308401926

Wu, Y., Yu, W., Wu, X., Wan, H., Wang, Y., & Lu, G. (2020). Psychological resilience and positive coping styles among Chinese undergraduate students: A cross-sectional study. *BMC Psychology, 8*(1), 1–11. https://doi.org/10.1186/s40359-020-00444-y

Xiang, Z., Tan, S., Kang, Q., Zhang, B., & Zhu, L. (2019). Longitudinal effects of examination stress on psychological well-being and a possible mediating role of self-esteem in Chinese high school students. *Journal of Happiness Studies, 20*(1), 283–305. https://doi.org/10.1007/s10902-017-9948-9

Xiang, G., Li, Q., Du, X., Liu, X., Xiao, M., & Chen, H. (2020). Links between family cohesion and subjective well-being in adolescents and early adults: The mediating role of self-concept clarity and hope. *Current Psychology*, 1–10. https://doi.org/10.1007/s12144-020-00795-0

Yarkoni, T., & Westfall, J. (2017). Choosing prediction over explanation in Psychology: Lessons from machine learning. *Perspectives on Psychological Science, 12*(6), 1100–1122. https://doi.org/10.1177/1745691617693393

Yıldırım, M., & Arslan, G. (2020). Exploring the associations between resilience, dispositional hope, preventive behaviours, subjective well-being, and psychological health among adults during early stage of COVID-19. *Current Psychology*, 1–11. https://doi.org/10.1007/s12144-020-01177-2

Yuen, M., Chung, Y. B., Lee, Q. A., Lau, P. S., Chan, R., Gysbers, N. C., & Shea, P. M. (2020). Meaning in life and school guidance programs: Adolescents' voices from Hong Kong. *International Journal for Educational and Vocational Guidance, 20*(3), 653–676. https://doi.org/10.1007/s10775-020-09423-6